"THE NEXT WAR"

AN APPEAL TO COMMON SENSE

BY

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AUTHOR OF "MEN, WOMEN AND WAR,"
"A REPORTER IN ARMAGEDDON," ETC.

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"A BIT OF A BRUTE"

The use of bayonet practice was moral; by it a blazing, vicious hatred was worked up in the common soldier.

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CHAPTER I

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title of a book lately published by Colonel Repington, is only a variant on this phrase.

Prophecy concerning the trend of political affairs is not only perilous but well-nigh impossible. In all the prophecy of the late war, who foretold the future course of Russia? There were whisperings, indeed in the Allied countries, there were loud forecasts in Germany, that Russia might withdraw from the Entente; but who prophesied the curious circumstances of her withdrawal and the still more curious results to which it led? Ten European statesmen believed that Holland, Switzerland or even Spain might enter the great war to one who counted on the United States. And who, before 1917, prophesied in what manner we would be the deciding factor or even hinted at our curious influence on the peace? Who looked forward and foresaw the American flag flying over the mighty fortress of Ehrenbreitstein at Coblenz?

Such affairs as these belong to the political side of war, partake of its uncertainty. It would be foolish, therefore, for even the wisest and best-informed statesman, and still less for a journalist, to prophesy what nations or combinations of nations might oppose forces in that "next war." The complexity of the question, involving as it does economics, internal politics, religion, sudden outbreaks of mob-mind, shifts of population, the rise of leaders as yet unknown, renders forecast impossible. Beside such a game, chess is as simple as jackstraws.

But forecasting the methods, strategies and effects of future wars is more like a purely mathematical problem, and infinitely easier. Such forecasts have been made in the past; and the best-informed and more intelligent of them have been vindicated by the course of events. Before the Russo-Japanese war, military critics who combined sound information with sound imagination said that in the next war between thoroughly prepared armies, the frontal lines would become deadlocked in trenches, and that battle could then be won only by a sudden and well-conceived surprise on the flank. That is exactly the history of the Russo-Japanese war; Nogi's great flanking movement won the battle of Mukden after the main forces had undergone some weeks of stalemate in the front trenches. Had the Russians possessed a single scout aeroplane, Nogi's success would have been impossible. The aeroplane appeared a few years later, proved itself not a toy but a practical machine. Then the military critics, of the class before mentioned made a new forecast. A war between densely-populated and thoroughly armed peoples such as those of Europe, they said, might be decided by an overwhelming initial thrust. Failing that, it must settle down to a long deadlock in trenches, a war of attrition with unprecedented losses, to be decided only when one side or the other crumpled up through exhaustion of economic resources and of morale. That view was expressed for the United States in Frederick Palmer's novel,

"The Last Shot." And these forecasts of the military critics might stand now as histories of the great war.

So it is possible to speak with some authority concerning the character of that "next war," especially since so many able Europeans have already recorded and analyzed the experiences and lessons of "the first world war." Though we cannot do more than guess at the participants, we can foresee the methods of that struggle and its direct and indirect results on the lives and property, the souls and bodies, of the nations who find themselves involved.

It is difficult, however, rightly to see the future without at least a glance at the past. It is doubly difficult in this discussion, because during the war of 1914-18 certain forces hitherto smouldering burst into blaze. Not only did the character of warfare change, but its whole relation to peoples and to human life. From now on, we must consider war in an entirely new light. An understanding of the difference between old wars and "the next war" is essential to an understanding of the present struggle between militarism and reasonable pacifism, between the aristocratic ideal of society and the democratic, between those who believe in that next war and those who are groping toward a state of society which will abolish war.

CHAPTER II

THE BREEDING OF CALAMITY

MAN alone, among the higher animals, seems characteristically to fight his own kind to the death. Doubtless before there was law or morals the primitive savage often got the woman, the ox or the stone knife which he wanted simply by killing the possessor. With the organization of society, groups and tribes began to do the same thing collectively as a means of acquiring live-stock, wives, slaves or territory; and we had war. In primitive society, if we may judge from our study of existing savages, wars were often comparatively bloodless affairs, settled by a contest between two champions or by a few wounds. Whole groups and tribes may have lived on the pacifist theory, as do today certain African nations which will not keep cattle because cattle bring on raids and peace is with them preferable to property.

When the curtain lifts on recorded history, tribes were collecting into nations, and kingship was firmly fixed in human affairs. By now, war also was a permanent human institution; every throne was propped up by an army. The relation of warfare to

this early progress has been traced by H. G. Wells in his "Outline of History." A people settled down, developed agriculture, town life, a literature, the mechanical arts, the beginnings of scientific knowledge; accumulated wealth and desirable luxuries. In this process, they became to the barbarian point of view "effeminate," and easy prey for conquest.

Warfare, then and for centuries afterwards, was mostly a matter of individual fighting. That side was the victor which had the greater average of men strong and skilled with the sword or lance, accurate with the bow. The settled peoples, busy with the arts of peace, had not the time for that life-long, intensive, athletic training which made good warriors. The barbarians, therefore, beat them in battle, took their wealth, settled down among them, learned their arts. They in turn became weakened for warfare, and another wave of barbarians repeated the process. Though there were exceptions, such as the long hold of the civilized Roman Empire, this was the general rhythm of ancient wars; even of mediæval wars.

Viewed in this light, we have reason for arguing that warfare was a positive if costly benefit. The world in general was without means of communication; the written word which carried knowledge was unavailable to whole peoples, to all but a few even among the most favored peoples. Travel beyond one's national boundaries was almost unknown;

the barbarians had an invariable custom of killing strangers. Possibly by no other means than warfare could the rudiments of civilization have reached the outer fringe. When the wild Persians overwhelmed them, the peoples of the Mesopotamian Basin had a written language, an understanding of primitive mechanics, a system of star-measurement. Left alone, they might have gone on to advanced mechanics such as the steam engine, to the truth about sidereal space and the world in space. The Persians blew out all that bright promise; yet before they themselves were conquered, they had acquired what their captives had learned. So it went, the world over, except in those three or four rather abnormal centuries during which Rome held sway over the world; and not even Rome was wholly an exception. She conquered Greece; but intellectually she became so absorbed by the Hellenic people that every Roman gentleman must speak perfect Greek or he was no gentleman. The Goths came into Southern Europe unlettered barbarians; in a few centuries, they had in Ravenna the most advanced civilization of their time; and they learned it all from the conquered. The Northmen got their letters, their mathematics, their mechanics from subject peoples. The German Junkers professed that they waged the late war to spread their culture by conquering; the ancient peoples spread their culture by being conquered. He would be indeed a preju-

diced pacifist who ignored this aspect of old war, or denied the possibility that in such times war was beneficial.

In those days of primitive nations warfare had no rules, or very few, of mercy or decency. The conquering king and his men, undeterred by scruples, did as they pleased with the conquered. If it served their whim or purpose, they slaughtered a surrendered army, even the women and children, of a whole surrendered tribe. The kingly inscriptions of Egypt and Assyria boast of such deeds as glories of the crown. When the tribe was spared, it was often merely that it might work to pay the victor tribute, or to furnish him with slaves. If there were protesting voices they have left no record. But as early as the great days of Greece, we find a little faint criticism both of war itself and its methods. The thing, certain men thought, was an evil, a calamity. It could not be stopped, probably; but it was an evil nevertheless. There did arise, however, a dim code—rudimentary morals of war. It was no longer quite ethical to kill women and children, to slaughter your prisoners. It was often done; but it required explanation and apology. When, some half-century before Christ, Julius Cæsar put to death the Usepetes and Tenectri, he was denounced in the Roman senate, and Cato even proposed that he be turned over to the Germans.

Christianity, when it came at last powerfully into human affairs, carried forward this moral move-

ment. A divine institution applied by imperfect men, it did not strike at the roots of war; nor indeed did it seem clearly to recognize them. It established, however, the principle that an unjust war was wicked; and it did strive to ameliorate the unnecessary horrors and to fix the tradition of chivalrous warfare. The Truce of God, by which it became wicked to fight on certain days of the week, was an attempt in this direction.

The movement collapsed in the great religious or half-religious wars of the sixteenth century, and for a reason quite logical and understandable. Both sides were fighting heresy, a sin and crime—they thought—which did not merely injure men in this life as do most ordinary crimes, but which condemned their souls to an eternity of misery. No punishment was too severe for heresy. Hence such massacres as those of the Thirty Years' War in Germany, and the sack of Antwerp in the Low Countries.

When mankind came out of this madness, the drift toward chivalrous warfare was resumed. The code, by the twentieth century, had become definite; it was a chapter in every general military text book, a course in the education of every professional soldier; finally it was sanctioned almost as international law by the Hague Peace Conference. In principle, war must rest as easily as possible on non-combatants such as women and children; nor might even an armed enemy be killed unnecessarily. In detail,

it was agreed that a city might not be besieged until the non-combatants had been given time to get away from the ensuing bombardment and starvation, that the victors holding occupied territory must be responsible for the lives of the inhabitants, that prisoners of wars must not only be spared but adequately fed and housed, that surgeons, nurses and stretcher-bearers must have every reasonable opportunity to rescue and succor the wounded; finally that certain "barbarous" methods of killing, such as explosive bullets and poison gases, might not be used. And the military clan of all nations generally accepted this code as the law and the gospel; they had been bred in the idea of chivalry, and had developed a beautiful and strict conception of professional ethics which implied truth and honor toward their own, and a sense of mercy toward their enemies. With such an attitude toward war, the nations entered the unprecedented struggle of 1914-18.

In the meantime, another current had been running among the European peoples; it is necessary to understand that in order to understand the present situation. In the period since the religious wars, in general during a long period before that, warfare had settled into the hands of professional armies, officered by the aristocracy, recruited in general from the dregs of the population, padded with mercenary soldiers of fortune. These forces were comparatively small, even in time of war.

In 1704, Marlborough won the battle of Blen-

heim and imposed his will on the Continent of Europe with 50,000 mixed British, Dutch and Austrian troops. France was considered, in this period, the great military power of the world. Just before the Revolution of 1789 her armies had a theoretical war strength of 210,000, or about one in 100 of the population. Nor was the economic burden of warfare very heavy. The weapons were comparatively few and primitive—flint lock muskets for the infantry, sabres and lances for the cavalry, plain smooth-bore cannon for the artillery. Speaking generally, ammunition consisted of four standard commodities—black powder, round lead bullets, flints, and solid cannon balls. The factories which supplied enough of this ammunition for the limited armies of the day represented only a very small part of the nation's productive forces. And, except in regions swept by the armies, the industries of the nations went on in war much as in peace. Even an unsuccessful war laid on the people only a comparatively light burden of taxation. The losses in men were not so great but that the general increase in races almost instantly filled the gap. At Blenheim, before mentioned, Marlborough lost less than five thousand men both killed and wounded, the defeated French and their Bavarian allies only eleven thousand.

Then came the French Revolution. The new, fanatical French Republic, opposed by an alliance of all the kings of Europe, its frontier invaded, its

nobility joined with the enemy, faced the alternative of a struggle with every resource it had or extinction and the gallows. The principle of conscription was decreed for the first time by a great nation. Every man capable of bearing arms must serve or hold himself ready to serve. And national industries also were mobilized, even if crudely. Theoretically, at least, all the iron-workers of France went to work on guns, cannon, pikes and ammunition. In the very streets of Paris stood the forges, hammering out bayonets.

There followed the twenty years of the Napoleonic wars, wherein conscription was applied in fact if not always in name. From that time, through fifty years of comparative peace, the thing grew as a principle of statecraft. It did not become settled and universal, however, until after the Franco-Prussian War of 1870. Prussia, ambitious leader of the German states, herself led by men with ruthless genius, had applied the principle of conscription, had planned and studied the possibilities of modern warfare as they had never been studied before. The German army was ready "to the last buckle" when it burst on France, swept up the brave but ill-organized army of MacMahon, took Metz and Paris, and in six months brought about a peace which tore from France two provinces, nearly her whole supply of iron ore, a discriminating tariff agreement, and the unprecedented indemnity of a billion dollars. Germany had shown the way to the militarists.

Now we must go back again and trace for a moment a third current, running into that cesspool which overflowed in 1914.

The era of kingship, as a focus for human loyalty, had passed into the era of Powers. And these Powers grew as predatory as the Roman Empire, though less frankly and obviously so. The age of machinery, of intensive manufacture, had arrived. Europe produced only a part of the raw materials which she needed for her furnaces, her forges or her looms. That country would prosper best, it was felt, which held the tightest grip on the sources of raw material. Every European nation was turning out more manufactured goods than it could use at home; all needed foreign trade; and "trade follows the flag." Finally, as national wealth was multiplied through the fruitful processes of machinery, Europe began to pile up surplus capital. Investment in new, undeveloped lands was much more profitable to capital than domestic investment under tight conditions.

Out beyond the fringes of European civilization lay barbaric and semi-civilized peoples owning raw materials, ready to buy European manufactured goods, promising still other benefits to the nation which could possess them either as conquerors or "protectors." It was easy for a European statesman, who wanted a fruitful barbarian country, to find the pretext. A native king, we will say, was encouraged to get hopelessly into debt with a Euro-

pean government or banking firm. An "incident" occurred. There were Europeans who made a trade of bringing on such incidents. National honor was offended; also, there was the debt. The army of the European power involved—sometimes bloodlessly, sometimes after a brief campaign—assumed the responsibilities of the native king. The debt was paid in time; but the European control remained. I describe here, and only as an example, one method among many.

When any given power so extended its "influence," it tried to make that influence exclusive. It must have all the raw materials and all the markets which it cared to take. It must have all the rights to invest capital. When the European nation, for fear of its rivals, could not take over any undeveloped nation outright, it tried to bring it at least within its "sphere of influence"—a kind of half-control leading in time to full conquest. The critics of this system call it "financial imperialism." For European diplomacy, backed by enormous armies, by great national banking houses, by munitions manufacturers, had become almost frankly commercial.

Diplomacy kept the long peace which this policy always endangered by a system borrowed from the eighteenth century and much improved in the nineteenth. "The Balance of Power" it used to be called; now it was termed "the Concert of the Powers." Nations, led by the great powers, allied themselves in such manner as to keep the opposing

sets of interests at about equal strength. If you expect to make a successful aggressive war, you must have a superiority of forces. Two nations about even in military resources are not likely to fight. The risk of failure is too great. And so with two alliances. But all this time, another current was running strongly among European nations. Each alliance was struggling to build up stronger potential power than the other. This helped when, as happened every four or five years, there rose a visible conflict of interests. The stronger you were in a military way, the stronger would be the situation of your diplomats. Every year, the European "race of armaments" grew more intense.

Expressed in less abstract terms, this was the general state of Europe during the forty or fifty years which followed the Franco-Prussian war:

On the Continent, military conscription had become universal. If Great Britain did not follow, it was because she, an island kingdom, was checking armies with an unprecedented navy. On the Continent, every young man must serve his two or three years with the colors, learning to be a modern soldier. Retired to the Reserve, he must at intervals drop his work and drill again, in order "to keep his sword bright." The financial burden of arming this soldier grew even greater. As I shall presently show, weapons of warfare never until recently improved so fast as industrial tools; but they did improve almost too rapidly for the finances of the

nations. The Germans decided that a repeating rifle could be used with advantage in infantry tactics; the French must scrap from five to ten million single-shot rifles and replace them by repeaters. When the British proved that a battleship of unprecedented size entirely armed with big guns could thrash any small battleship armed with guns of mixed calibres, all existing battleships were headed toward the junk-yard, and the rival nations must build dreadnoughts. When France worked out a field-gun unprecedented for accuracy and rapidity of fire, thousands of German field-guns must go to the melting-pot or to museums, to be replaced by imitations of the French "soixante-quinze." And the expense of these improvements increased almost in arithmetical ratio. A repeating rifle, with its complicated mechanism, cost much more than a smooth bore. "First-line" ships for modern navies cost in the seventies one or two million dollars; a crack dreadnought costs now a matter of forty or fifty million dollars. The burden of taxation weighed heavier and ever heavier on the common man and woman of Europe. There were signs just before the Great War that the race of armament was slowing up. Nations seemed to hesitate about adopting obvious but costly improvements. The true cause back of this, doubtless, was that taxation was reaching the "point of saturation"—for peace times at least. Agitation against military service began to make itself heard. It took two years from the work-

ing life of every able-bodied young man; and its obvious end was not creation of wealth, but destruction.

But the nations in general could not let go, even had their statesmen desired to renounce "Financial Imperialism" and its buttress of great standing armies. If for no other reason, because Germany sat in the centre of Europe, unconverted to any theories which involved military disarmament; and England sat behind her sea walls, afraid of any theories which involved naval disarmament. But Germany was setting the pace. She had learned the "lesson" of the Franco-Prussian war—a "nation in arms," an army methodically, scientifically prepared from its boots to its plan of campaign, eternally ready for that sudden stroke which catches the enemy unprepared. Scientific military preparation had laid the foundations for the prosperity and greatness of modern Germany. More scientific preparation—more prosperity and greatness! That German genius for organization, scarcely suspected before 1870, sprang into full blaze. And the army was organized into every German institution. The state schools educated the children to make them not only good citizens and efficient workers, but also good soldiers. With a skill and thoroughness which was the marvel of its time, Germany wove the army into the fabric of civilian life. Her state railways were laid down not only for commercial needs but also with a view to moving great bodies of troops

toward any critical point on the frontiers. Her great steel works, making and exporting the tools and machinery of civilian life, could be changed over with a minimum of trouble into factories for munitions of war. She specialized, indeed, on munition making—furnished the rifles and cannon for the little wars of the far countries.

The "psychological preparation" imposed by the rulers of Germany was just as thorough. A state-controlled pulpit, a state-controlled press, state-controlled teachers and university professors, hammered or insinuated into the German people exaggerated, conceited patriotism and the thought of war—the "Religion of Valor." With the national talent for intellectual speculation, the Germans of the governing class worked out a philosophy which sounds quaint to practical-minded Americans, but upon which men lived and died. The state was a thing with a soul. It was the duty of the subject, his highest end, to advance the glory and interest of the state, no matter if that glory made every subject poorer and less happy. We, of course, look upon the state as a means of getting together and promoting the happiness and security of its members. If it does not generally have that result, it is nothing. When it comes to promoting the interests of the state—this philosophy held—all ordinary rules of morals are off. Acts like theft, murder, unchastity, cruelty, calling for severe punishment when

performed against other citizens of the state, became holy when performed for the state.

War was the highest manifestation of the state, the supreme act which gave it glory, the opportunity for the subject to prove his devotion. War was good in itself. It was, first of all, natural. All biological life was a struggle. The weak went down, the strong survived; by this process the species evolved and improved. So, the weaker races go down before the stronger, for the improvement of the human breed*. Of course, your own race was the strongest, the most worthy of survival. Races grew soft in peace, strong in war. The talk about doing away with warfare was "immoral, unnatural, degrading."

Such, briefly, were the ideas upon which Germany was being fed. We all know that, I suppose. Most of us have heard of Bernhardi and his book "Germany and the Next War"—the extreme expression of this view. What we do not perhaps appreciate is that such opinions were not peculiar to Germany. In the Great War, in the settlement after the Great War, Europe was divided not only by a horizontal

*I shall treat later on of other articles of this faith but this one might as well be nailed here and now. Admitting what is popularly called the Darwinian theory of the origin of species through survival of the fittest, evolutionists still doubt whether man did not free himself from the law of evolution at the moment when he fashioned the first tool, built the first fire. From that time, he became not the creature of his environment, but its master. But even if the man-species still lives, grows and improves by the law of evolution, the struggle for existence is, in the natural, animal state, between individual and individual, not between tribe and tribe, horde and horde. This is like many other militarist arguments; it is neither true nor scientific; it only seems so.

line between Entente Allies and Germanic Allies, but by a vertical line between the aristocratic element and the democratic element. The set of ideas which I have quoted above were distinctly aristocratic in their aims and origins; by an aristocracy in secure control they were disseminated. But the other European aristocracies held exactly the same view—not so logically worked out perhaps, not so frankly expressed, but the same at the bottom. Lord Roberts, the venerable and respected British general, issued a kind of manifesto at the beginning of the war. Less brutal and feverish in expression, it is in thought the same thing as the mouthings of the German Junkers. "War is necessary for the souls of people," he said in effect; "it is the tonic of races." You heard the same sentiments from the French General Staff. The difference was only this: whereas in the Entente countries the democratic idea kept a balance with the aristocratic as in Great Britain and Italy, or maintained the ascendence as in France, the aristocratic element held in Germany the control over government, over most material activities, over most sources of public opinion. Germany, said the aristocrats of the neutral European nations, had made aristocracy scientific, brought it up to date, showed how it could be fastened on to a modern state. That was why these neutral aristocracies were one and all pro-German.

There were German dissenters, of course. There were in fact many of them, as the Social Democratic

vote showed in 1913, the Revolution in 1918. But their dissent was as yet ineffective. Probably the majority of Germans believed in this Religion of Valor which they had learned with their Christian prayers. Certainly the majority believed that the intensive, perpetual preparation for instant war was a necessity to a nation "ringed with enemies." The preparation went on, ever and ever more burdensome and complex. So did the propaganda, the "mental preparation." By 1914, the Germans published and read more books on war than all the other nations of the world put together. "The man who builds the ship will want to sail it," say the nautical experts. And the man who forges the sword will want to wield it. By 1914, the mine was laid and ready. With their "financial imperialism," their "concert of the powers," their race for dominating armament, all the European nations were responsible for that. The assassination of an Austrian prince, a mere police court case, lit the fuse. Accident alone was responsible for that. The fuse might have been trampled out; but the Kaiser and his counsellors held back, held others back. Germany was responsible for that—Germany and an aristocratic, militarist system, "prepared to the last buckle." On the day of mobilization, the French conscripts went to their appointed places sober or pale or weeping according to their individual characters. The first young British volunteers marched to the recruiting offices with a solemn consecration

in their faces, as men who go to take a sacrament. The Germans rushed to arms shouting and singing. During the early days of the Belgian invasion a German Junker officer, who seemed well informed upon events within the enemy lines, spoke to me with tears of pride in his eyes concerning this contrast.

"Ah, Germany was beautiful—beautiful!" he said.

CHAPTER III

SECOND YPRES

So the nations went to war, armed to the teeth, ready as nations never were before. It was to be a supreme struggle; all intelligent Europe knew that. Every available ounce of national resource, human material and energy was necessary to victory. If the rest did not understand, Germany soon taught them. And from the beginning, the "code of civilized warfare" began to melt away. In the first week, Great Britain and Germany both violated its spirit if not its letter. It was provided in the code that when siege was laid to a city the non-combatants must have a chance to get away in order to escape starvation as well as bombardment. With her dominant navy, England at once put a food-blockade on Germany. She knew that Germany produced but 80 per cent of her own food; and that this was done only through intensive fertilization and the employment in harvest and plowing time of a mil[illegible] and a half Russian laborers. The state of [illegible] reduce the supply of fertilizers, w[illegible] Russian laborers, would take fro[illegible] the domestic laborers. It was pos[illegible]

failing, to starve out Germany, the weakest civilian baby as well as the strongest soldier. From the first day of the war—in plan if not at once in action—Germany prepared in the same way to starve out the British Isles with submarines. When she applied her submarine campaign, Germany violated at once an old article of the code which provided that merchant ships, about to be sunk for carrying contraband, must be warned and searched and that their crews must be allowed to escape. She began to sink without warning. If Germany abandoned this method in 1915, it was only because the United States protested, and she feared to drag us into the war against her. She resumed her original plan in 1917, and we did enter the war.

It was provided in the code that civilians should be given warning of a bombardment. But the aeroplanes had arrived; and aeroplane tactics depend not only upon speed but upon surprise. In the first fortnight of the war and as unexpectedly as a bolt of lightning from a clear sky, a German Taube appeared over Paris, dropped a bomb which blew in the front of a shop and killed two civilian butchers peacefully wrapping up meat. Germany invaded Belgium. As part of her long-studied plan for keeping everything serene on her line of communications against France, she seized as hostages a few leading citizens of each town through which she passed, shot them if the town did not behave. And the taking of hostages had been so long abrogated

by the code that a French Encyclopedia of War issued in the sixties of the last century defined it as "a usage of barbarous and semi-civilized warfare, for centuries discontinued by civilized nations." The "code" was going fast. A structure of merciful if superficial ethics which had been three centuries building was toppled over in two weeks.

Eight months later, humanity arrived at a date as significant in our annals, I think, as October 12, 1492 or July 4, 1776. It is April 22, 1915, during the Second Battle of Ypres. That day, the Germans rolled across the Western trench-line a cloud of iridescent chlorine gas which sent French, Arab, English and Canadian soldiers by the thousands back to the hospitals, coughing and choking themselves to death from rotted, inflamed lungs. Had the German General Staff possessed imagination enough to use gas wholesale instead of retail on that day, they might have won their war then and there.

The significance of the second Battle of Ypres needs explanation.

Through all the centuries of mechanical and scientific improvement, military armament—the means of killing men—had lagged behind. The primitive man killed in war by hitting his opponent with a hard substance—a club or stone. Later, he sharpened the stone so that it would more readily reach a vital spot, and had a knife or a sword. He mounted the knife on a stick to give himself greater reach, and had a spear. He discovered the projecting power of the

bow, which would send a small spear beyond his own reach. Gunpowder arrived; that gave still further and more powerful projection. But the principle, the one method of killing a man in war, remained the same—hit him with something hard. We had learned many ways of controlling and transmuting for the purposes of ordinary life the power stored up by the sun—steam, electricity, the energy of falling water. Military science knew but one way—the explosion of chemicals. If we look into a battleship, that "great, floating watch," we marvel at the intricacy of her machinery. But we should find that the engines, the turbines, the delicate and complicated electrical instruments, are all devices first invented for purely industrial activities and merely adapted for war. We should find the guns, the actual killing instrument, among the simplest machines on board. In centuries of mechanical invention and mechanical improvement, very little higher intelligence and no genius at all had been put into the mechanics of killing men.

There were good reasons. The men who discovered the great principles back of modern machinery and industrial method, such as Newton in physics, Friar Bacon and Faraday in chemistry, Ampère and Volta in electricity, were concerned only with pure science, with extending the field of human knowledge. The clever inventors and adapters—such as Stephenson with his locomotive, Morse with his telegraph, Edison with his electric light and phono-

graph, Marconi with his wireless, Langley and the Wrights with their aeroplanes—were concerned with improving the civilian processes of production and transportation, or with adding material richness to modern life. Those who, in biology and kindred sciences, followed the paths blazed by the giants of the nineteenth century, were even more directly benevolent in their ends. Ehrlich and Takamine worked to save, preserve and lengthen human life. No first-class scientific mind was interested in research having for its end to destroy human life.

Nor did the military caste, whose business—stripped of all its gold lace and brass buttons—was to kill, add anything fundamental to the science of destruction. It is traditional that what few real improvements there have been in armament, such as the machine-gun and the submarine, were invented by civilians and by them sold to armies. Military life tends to destroy originality. It makes for daring action, makes against daring thought. In the second place, there was the code. Professional soldiers wanted, sincerely wanted, to render warfare as merciful as possible. They shrank from carrying the thing out to its logical conclusion. Killing by gas had been theoretically proposed long before the war; and most military men had repudiated the idea. They had even fixed their objection in the stern agreements of the Second Hague Conference.

But from April 22, 1915 that agreement and all similar agreements were abrogated. The Germans

had found a new method, with enormous possibilities, for killing men. This weapon was powerful enough to win the war, if the Allies refused to reply in kind. They did reply in kind. From that moment, to use the language of the streets, the lid was off. Nations, instead of merely armies, were by now mobilized for war. Those great and little scientific minds, engaged hitherto in searching for abstract truth or in multiplying the richness of life and the wealth of nations, could be turned toward the invention of means of destruction whether they wished or no. A new area of human consciousness was brought to fruition. A new power in men was unloosed and this one most sinister. Its established past performances, its probable future results, I shall consider elsewhere.

This release and stimulation of the human imagination for the business of killing was perhaps the main social event of the Great War. But I hinted at another almost equally important when I said above that nations instead of armies were now mobilized for war.

The Germans had entered Armageddon with an unprecedented equipment of munitions. The electric-minded French perceived at once, the slower-minded British only a little later, that this was to be a war of factories as well as of men and bent all their resources toward organizing the national life for this purpose. Every woman enlisted in muni-

tions-making, in agriculture, in clerical work for the business offices of war, released a soldier to the Front. Women were drawn in by the thousands, later by the millions. At the end of the war Great Britain, homeland and Colonies together, had in arms less than five million soldiers; but homeland and Colonies together were employing three million women in the direct processes of war, besides millions of others who gave as volunteers a part of their time. It became a stock statement that if the women of either side should quit their war-work, that side would lose.

Now since munitions and food had grown as important as men, since to stop or hinder the enemy munitions manufacture or agricultural production was to make toward victory, the women in war were fair game. Near London stood the great Woolwich munition works and armory, turning out guns, explosives and shells. Probably before the end of the war, as many women worked there as men. It was raided again and again by German aircraft. Why not? Totally to destroy the Woolwich works would be equivalent for purposes of victory to destroying several divisions. The old code was logical for its time when it forbade the killing of women and other non-combatants. Then, killing a woman had no point. Now it had a most significant point.

The same stern logic of "military necessity" lay behind the continual air raids on cities, fortified and

unfortified. Germany began this process. She was in a position to do so. She held the advanced lines. Her front was only seventy miles from the capital and metropolis of France, less than a hundred from that of Britain, whereas, to attack Berlin, the Entente Allies must travel by air nearly four hundred miles. Tons of illogically sentimental propaganda have been published concerning these air-raids. In the beginning, the intention was, on any standard barbarous, cruel, and stupid. The German General Staff, rich in scientific knowledge but poor in the understanding of human nature, thought by this means to "break down the resistance" of the hostile peoples, to bully them into a submissive attitude. In this they failed utterly; air raids had rather the effect of lashing the French and British into increased effort.

But the raids were continued for a more practical purpose. The nerve-centres of war are in the great cities, and mainly in the capitals. Suppose for an extreme example that the Germans in one overwhelming raid or a series of raids had destroyed Paris. All the main railroad lines which supplied the army at the front ran through Paris. There, the trains were switched, rearranged and made up. In Paris also were the headquarters of those innumerable bureaus vitally necessary to the conduct of modern war, with all its complexities and coordinations. Had the railroad connections been destroyed, had the bureaus lost their quarters, their

books, their personnel, the French army at the front must have been thrown into confusion.

By the same token the more they approximated to this end, the more the air-bombardments made toward victory. Both Parisians and Londoners have expressed to me the opinion that the Gotha raids and the Big Bertha bombardments were "worth while" for the effect they had on the business of life. "There's no use in denying," said an Englishman, "that we did less work than usual—at least a quarter less—on the days of air raids."

Still further: defence against air-raids is very difficult; so the French, for example, were forced to hold back from the Front in order to defend their capital scores of aeroplanes and many batteries of guns, whereas the Germans seldom raided with more than a dozen aeroplanes. That factor alone made air raids useful for strictly military ends. When the Allies began raiding German cities in 1917 and 1918, when they prepared to raid Berlin on an unprecedented scale in that campaign of 1919 which never occurred, they were not mainly inspired by revenge, as horror-stricken German civilians and war-heated Allied civilians asserted. The General Staff were after results, not personal satisfaction. They knew that aeroplane raids on cities brought military results. Still further; they knew that armies exist and operate for the defence of peoples. The object of wars, after all, is not the destruction of armies. It is the subjugation of peoples. In strik-

ing at the great cities they were striking, a little blindly as yet but still directly, at the heart of resistance.

Of course, when you attack and bombard a city without warning—and an air raid, to be effective must come without warning—you include in the circle of destruction every living thing in that city, the weakest non-combatant with the strongest soldier. "Baby killers" the Londoners called the Zeppelins. They were just that; for baby-killing had become incidental to military necessity.

Let me here add another departure from the "code," less significant than the new ways of killing and the inclusion of all civilians in the circle of destruction, but still important to humanity. Under its spirit, usually under the letter, an army destroyed property only when that destruction would weaken the enemy's armed forces and his general military resistance. Sherman's devastation during his march to the sea was ruthless and terrible, and is not yet forgotten in the South. But it had a direct military object—to render impossible the provisioning of the Confederate Army. The Germans, setting the pace, carried the logic of destruction one stage further. In their early rush they had taken and held securely the coal mines of Northern France. Those mines, yielding half of the French native coal supply, they deliberately flooded and destroyed. This had no immediate military purpose. In German hands, the mines were useless to the

French army. No, the German General Staff wanted simply to weaken France permanently, to make that part which they did not seize in their proposed German peace a subject nation commercially. The collapse of the Germans in 1918 was so sudden that the Allies did not enter her territory while in a state of war and it is impossible to say that they would not, in other circumstances, have followed the general rule of war and replied in kind.

Let me go no further with all this, but summarize: "The Code," a merciful though artificial body of ethics, built up by Christianity and all other humanitarian forces through two thousand years of warfare, had collapsed. In most respects, we were back to the ethics of the barbarian hordes. The barbarians of the twentieth century B. C. killed in any manner which their imaginations suggested; so now did civilized men of the twentieth century A. D. The barbarian of the twentieth century B. C. killed the women and children of the enemy as tribal self-interest seemed to dictate; as now did the civilized men of the twentieth century A. D. The barbarians of the twentieth century B. C. made slaves of the conquered people or forced them to pay tribute; so virtually—in such acts as the destruction of the French mines—did civilized men of the twentieth century A. D.

In only two important respects did the code still stand when we emerged from the Great War of 1914-18. We were generally sparing prisoners,

granting life to those who gave up resistance and surrendered. But would this article have stood in case the war went on? Germany held several millions of French, British, Belgian, Italian and Russian prisoners. At an ever-increasing pace, she was being starved out. Suppose she had elected to defend herself literally to the last life, as besieged cities have often done? With an underfed army, with civilians dropping dead of starvation in the streets—what of the prisoners? She could not send them back to multiply the number of her enemies. She could not dump them into the adjacent neutral nations to devour their scanty supplies of food. Rather than face this, Switzerland or Holland would have entered the war against Germany. What might have become of the prisoners?

Only one article of the code stood firm. With occasional violations, the "right of the wounded" was respected. Speaking generally, both sides spared the hospitals.

And with the break-down of "the code," another sinister factor, unknown to the barbarians, had entered warfare—that exact scientific method of research which has wrought all our miracles of industry was at the service of the warriors. The current of scientific work and thought, flowing hitherto toward improvement of mankind, was now dammed; it was flowing backward, toward the destruction of mankind.

CHAPTER IV

THE NEW WARFARE

Now let us take up one by one the new factors in warfare introduced by the Great War of 1914-18, and see what effects they had on that war, what inevitable or probable effects on "the next war." To make it all easier to follow, let us begin with that factor which we can grasp most readily—the business of killing. Here, in treating of the past, I shall take testimony of the war itself mostly from my own direct or second-hand observations, extending from the Battle of Mons to the Battle of the Argonne; and in speculating on the future mostly from the sayings and writings of professional soldiers, many of them—though not all—thorough believers in militarism and "the next war."

After the Second Battle of Ypres lifted the lid, those men of science, those high technicians, who had put themselves at the service of armies, experimented with new methods of killing. Liquid flame—burning men alive—was introduced on the Western front. This proved of only limited usefulness. The British introduced the tanks. These were important to the general change in warfare, as I shall

show later; but they added nothing to the direct process of destroying life. Gas seemed by all odds the most promising of the new weapons. That simple chlorine which the Germans used in 1915 gave place to other gases more complex and more destructive to human body-cells. At first released only in clouds and dependent upon a favorable wind for their effect, the chemicals which generated these gases were later loaded into shells and projected miles beyond any danger to the army which employed them.

As gas improved, so did the defence against it. The crude mouth-pads, consisting of a strip of gauze soaked in "anti-chlorine" chemicals, which the women of England rushed to the Front after Second Ypres, were succeeded by more secure and cumbersome masks. The standard mask worn by the Americans in 1918 was a complex machine. It was cleverly constructed to fit the face air-tight; its tank held antidotes for all known German gases. However, this was an imperfect protection, because men could not or would not wear it all the time. It took the sternest discipline to make troops keep on their masks even in time of danger. Surprise gas-bombardments were always catching them unmasked. A slight leak was fatal. In that stage of chemical warfare, the losses from gas-shells in proportion to the quantity used, were at least as great as those from high-explosive shells.

Yet the mask was a protection; let us therefore

study to beat it. In the spring attack of 1918, the Germans introduced their "mustard gas." Unlike its forerunners, it was poisonous to the skin as well as to the lungs. Breathed, it was deadly; where it touched the skin, it produced terrible burns which resisted all ordinary treatment. These wounds were not fatal unless they covered great areas of the body. In that, mustard gas was unsatisfactory.

Now in all the experiments following Second Ypres, the chemists had in mind three qualities of the ideal killing gas. First, it should be invisible, thus introducing the element of surprise. The early, crude gases, even in small quantities, betrayed their presence by the tinge they gave the atmosphere. Second, it should be a little heavier than the atmosphere; it should tend to sink, so as to penetrate dugouts and cellars. Third, it should poison—not merely burn—all exposed areas of the body. American ingenuity solved the problem. At the time of the Armistice, we were manufacturing for the campaign of 1919 our Lewisite gas. It was invisible; it was a sinking gas, which would search out the refugees of dugouts and cellars; if breathed, it killed at once—and it killed not only through the lungs. Wherever it settled on the skin, it produced a poison which penetrated the system and brought almost certain death. It was inimical to all cell-life, animal or vegetable. Masks alone were of no use against it. Further, it had *fifty-five times* the "spread" of any poison gas hitherto used in the war.

An expert has said that a dozen Lewisite air bombs of the greatest size in use during 1918 might with a favorable wind have eliminated the population of Berlin. Possibly he exaggerated, but probably not greatly. The Armistice came; but gas research went on. Now we have more than a hint of a gas beyond Lewisite. It cannot be much more deadly; but in proportion to the amount of chemical which generates it, the spread is far greater. A mere capsule of this gas in a small grenade can generate square rods and even acres of death in the absolute. . . .

So much at present for gas. It is the new factor, the one which may hold the greatest promise for future improvement in war. But there has been much improvement in certain methods already known and used, which in future wars may be auxiliary to gas. There was the old, stock weapon of modern wars—the tube from which hard substances were projected by chemical explosion—in short, the gun. In proportion to initial cost, the power of the gun and of the auxiliary explosion its chemical had increased enormously. The smokeless TNT and other high explosives employed in this war were but little more expensive, pound for pound, than the old black powder of past wars; in effect they were incomparably more destructive. Men in war defended themselves against this increased destructive power by an old method made new; they burrowed deep into the inert earth. But even at that, destruction proceeded faster than the defence against destruc-

tion—hence the unprecedented death-list of this war.

When we came to the vital element of property—the accumulated wealth of the world—we find the disparity between cost and effect much greater.

Let us reason here by example: the battle of Waterloo, whose glories and horrors Europe sang for a hundred years, resolved itself at one stage into a struggle for Hougoumont Château. All through the battle, French and British regiments, supported by artillery, were fighting for that group of buildings. The guide to the Château points out to the tourist the existing marks of artillery fire and the restorations. A corner knocked off from the chapel, a tiny outhouse battered down, a few holes in the walls no bigger at most than a wash-tub—that is the extent of the damage. Now while it is impossible to make an accurate estimate, it is still quite certain that the damage to Hougoumont Château was smaller in money value than the cost of the cannon-balls, shells and gun-powder which caused it. By contrast: during 1916, the Germans dropped into the town of Nancy some of their 380-millimetre shells—the largest and most expensive generally used in the war. The cost of such shells was probably between three and four thousand dollars. I was in Nancy during one such bombardment, when a big school house was hit directly. It seemed literally to have melted. In restoring it after the war, the French had to rebuild from the ground. And that school house cost more than two hundred thousand dollars. As a gen-

eral rule, when a shell of the Great War hit a building, it destroyed much more value in property than its own cost plus that of its projecting charge. The shells which missed are aside from this discussion; for the artillerymen of Napoleon's army missed just as often in proportion.

Yet Nature always imposes limits on human ingenuity. We arrive at a point beyond which we cannot much further improve any given device. Military experts generally agree that we have about reached that impasse with guns and their explosive projectiles. The "Big Bertha" which bombarded Paris from a distance of seventy miles was only an apparent exception. It was not a real improvement; it was a "morale gun," useful to the "psychological campaign" of the Germans. It had no accuracy; the gunners "ranged" it on Paris in general, and the shells, according to atmospheric conditions, fell anywhere over an area some four or five miles across.

No; there will be no great improvements in guns and high-explosive projectiles. Even if we have not reached the limit of invention, other methods of destroying life and property hold out much more promise. Among these is the aeroplane. There, we have not nearly reached the barrier set by Nature upon Ingenuity.

A modern weapon works by two distinct processes—the projection, which sends the death-tool far into the region of the enemy and the action—usually some kind of explosion—by which it kills. The

bombing aeroplane is essentially an instrument of projection. It extends "range" beyond any distance possible to a gun. The army aeroplanes of 1914 were, in 1916, mentioned by the aviators as "those old-fashioned 'busses'." In 1918, airmen employed similar scornful language concerning the machines of 1916. However, the range of the 1914 aeroplanes greatly excelled that of any gun; they could venture at least a hundred miles from their bases. By 1918, they were venturing two or three hundred miles; and the Allied armies planned, in the spring of 1919, to make regular raids on Berlin, some four hundred miles away.

To adopt again the terminology of artillery; as the aeroplane grew in range, so did it grow in calibre. The bombs dropped on Paris in 1914 were not much bigger than a grape-fruit; the bombs prepared for Berlin in 1919 were eight feet high and carried half a ton of explosive, or gas-generating chemicals. Not only were they greater in themselves than any gun-shell, but they carried a heavier bursting-charge in proportion to their size. As you increase the calibre and range of a gun, you must increase the thickness of the steel casing which forms the shell, and correspondingly reduce the proportion of explosives or gas-forming chemical. But an air bomb—which is dropped, not fired—needs only a very thin casing. A big shell is in bulk mostly steel; an air bomb is mostly chemical. It was in shells like these that we would have packed our

Lewisite gas had we decided to "eliminate all life in Berlin."

However, air-bombardment was during the Great War essentially inaccurate. A gun, in land operations, is fired from a solid base; the artilleryman can aim at his leisure. A bomb is dropped from a base which is not only in rapid motion but partakes of the instability of the air; the bombing aviator must make an inconceivably rapid snapshot. Still, even at this crude stage, air-fire grew much more accurate. In 1914 and 1915, the bombs seldom hit their objective, unless that objective were a city in general. By 1918, they were usually hitting on or near their targets. It was still, however, mostly a matter of individual skill, not of accurate machine-work.

Then, just before the Armistice, an American, binding together many inventions made by civilians for civilian purposes, showed a dazzling way to the warfare of the future. He proved that aeroplanes, flying without pilots, could be steered accurately by wireless. This meant that the aeroplane had become a super-gun. Calibre was increased indefinitely. An aeroplane could now carry explosive-charges or gas-charges up to its whole lifting capacity of many tons. It was no longer merely a vehicle; it could be virtually a self-propelling shell. And in the matter of accuracy, the uncertain human factor was nearly eliminated, as happens in most highly-improved machines. An expert on this kind

of marksmanship, hovering in an aeroplane or Zepplin many miles away, with a fleet of protecting battle-planes guarding him to prevent hurried workmanship, could guide these explosive fleets to their objective whether town or fortress. Here, in effect, was a gun with a range as long as the width of European nations, a bursting charge beyond the previous imaginations of gunnery.

CHAPTER V

TACTICS OF THE NEXT WAR

Now before going further, let us pull together our argument, so far as it has gone.

Here is a projectile—the bomb-carrying aeroplane—of unprecedented size and almost unlimited range; here is a killing instrument—gas—of a power beyond the dream of a madman; here is a scheme of warfare which inevitably draws those who were hitherto regarded as non-combatants into the category of fair game. We need but combine these three factors in our imaginations, and we have a probability of "the next war" between civilized and prepared nations. It will be, in one phase, a war of aeroplanes loaded with gas shells. And professional military men in all lands are remarking among themselves that the new warfare may—some say must—strike not only at armies but at the heart of the matter—peoples.

A Prussian officer, of the old school said to his American captor in 1918, "France is the sheepfold and Germany is the wolf. The French army is the shepherd's dog. The wolf fights the dog only in order to get at the sheep. It is the sheepfold we

want." Upon such sentiments the Allied world looked with some horror—then. Even the Germans somewhat withheld their hands. I cannot find that gas-bombardment was ever used on the cities behind the lines. Yet the Germans were preparing in 1918 a step toward that method. Had the war continued, Paris would have been attacked from the air on a new plan. A first wave of aeroplanes would have dropped on the city roofs tons of small bombs which released burning phosphorus —that flame cannot be extinguished by water. It would have started a conflagration against which the Fire Department would have been almost powerless, in a hundred quarters of the city. Into the light furnished by this general fire, the Germans proposed to send second and third waves of aeroplanes loaded with the heaviest bombs; they could pick their objectives in the vital parts of the city as they could not during an ordinary moonlight raid. From that the gas-bombardment would have been but a step. I have shown what we might have done to Berlin in 1919 with giant bombs carrying Lewisite gas. The Allies, I can testify personally, did not intend to use this method "unless they had to." But the elimination of civilians by the hundreds of thousands, perhaps by the millions, through gas bombardments, was a possibility had the war continued until 1920.

In "the next war," this gas-bombardment of capitals and great towns is not only a possibility but a strong probability—almost a certainty. Military

staffs have had time to think, to carry out the changes and discoveries of the Great War to their logical conclusion. They see that even with the known gases, the existing aeroplanes, Paris, Rome or London could in one night be changed from a metropolis to a necroplis. If any military man hesitates to apply this method—and being human and having a professional dislike of killing civilians, he must hesitate—the thought of what the enemy might do drives him on to consideration of this plan of warfare, and to preparation. There are at this moment at least two elements in the world quite capable of turning this trick had they the means and control. The method is so effective that if you do not use it, some one else will. You must be prepared to counter, to reply in kind.

Here are the words of a few authorities:

Brigadier General Mitchell of the United States Army, pleading with the House Committee on appropriations for more defensive aeroplanes, said that "a few planes could visit New York as the central point of a territory 100 miles square every eight days and drop enough gas to keep the entire area inundated . . . 200 tons of phosgene gas could be laid every eight days and would be enough to kill every inhabitant."

Captain Bradner, Chief of Research of the Chemical Warfare Service, said at a Congressional hearing:

"One plane carrying two tons of the liquid [a

certain gas-generating compound] could cover an area of 100 feet wide and 7 miles long, and could deposit enough material to kill every man in that area by action on his skin. It would be entirely possible for this country to manufacture several thousand tons a day, provided the necessary plants had been built. If Germany had had 4,000 tons of this material and 300 or 400 planes equipped in this way for its distribution, the entire first American army would have been annihilated in 10 or 12 hours."

Brevet Colonel J. F. C. Fuller this year won in England the Gold Medal of the Royal United Service Institution for his essay on the warfare of the future. All through, he avoids this topic of attacks on the civilian population; he is treating, like a true old-time military man, of armies alone. But Fuller says concerning the general possibilities of gas, which he believes to be the weapon of the future: "It is quite conceivable that many gases may be discovered which will penetrate all known gas armor. As there is no reason why one man should not be able to release 100 cylinders simultaneously, there is no reason why he should not release several million; in fact, these might be released in England today electrically by a one-armed cripple sitting in Kamchatka directly his indicator denoted a favorable wind."

And Major-General E. D. Swinton, of the British army, said in discussing Colonel Fuller's paper:

"It has been rather our tendency up to the pres-

ent to look upon warfare from the retail point of view—of killing men by fifties or hundreds or thousands. But when you speak of gas . . . you must remember that you are discussing a weapon which must be considered from the wholesale point of view and if you use it—and I do not know of any reason why you should not—you may kill hundreds of thousands of men, or at any rate disable them."

Here, perhaps, is the place to say that Lewisite and the gas beyond Lewisite are probably no longer the exclusive secret of the United States Government. We had allies in this war; doubtless they learned the formula. Even if not; once science knows that a formula exists, its rediscovery is only a matter of patient research, not of genius. And gas-investigation is quietly going on abroad. If they have not arrived at the same substances, the chemists of Europe have worked out others just as deadly. The scientific investigation of the killing possibilities in gas is only four years old.

Colonel Fuller says bluntly in his illuminating essay that the armies which entered the late war were antiquated human machines, that military brains had ossified. Warfare, he says, must be, will be, brought up to the standard of civilian technique. Henceforth, general staffs must not wait for unstimulated civilians to invent new machines or methods of attack and defence. They must mobilize high technicians and inventors in the "pause between wars" as well as in war, bend all their energies

toward discovering new ways of killing. And virtually, that improvement in warfare is already begun. In the laboratories of Europe,—just as the farseeing prophesied after Second Ypres—men are studying new ways to destroy life.

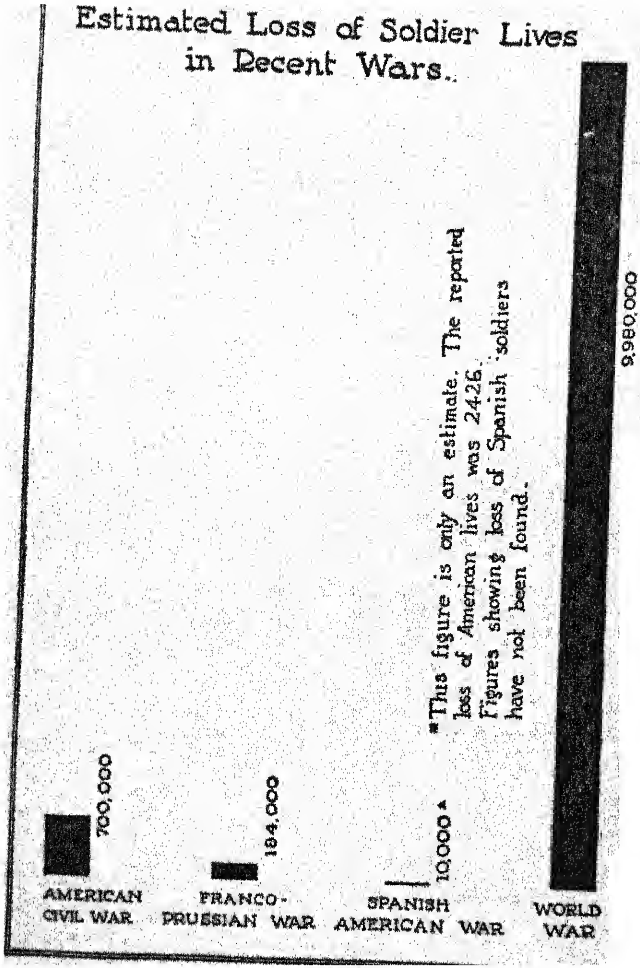
Scientific discovery involves the factors of leisure. To reach great things, a man cannot be hurried. War is all organized hurry. With both sides racing for victory, the savants of Europe had not the leisure to reach out toward the unknown. They worked with poison gas; that was already discovered, and merely needed improvement. Now, in the pause since the Armistice, they are venturing into the unknown. Let us take testimony again from the public and official remarks of General Swinton:

". . . ray warfare. I imagine from the progress that has been made in the past that in the future we will not have recourse to gas alone, but will employ every force of nature that we can; and there is a tendency at present for progress in the development of the different forms of rays that can be turned to lethal purposes. We have X-rays, we have light rays, we have heat rays. . . . We may not be so very far from the development of some kinds of lethal ray which will shrivel up or paralyze or poison human beings . . . The final form of human strife, as I regard it, is germ warfare. I think it will come to that; and so far as I can see there is no reason why it should not, if you mean to fight. . . . prepare now . . . . we must envisage these new forms of

warfare, and as far as possible expend energy, time and money in encouraging our inventors and scientists to study the waging of war on a wholesale scale instead of . . . thinking so much about methods which will kill a few individuals only at a time."

In the war just finished,—according to neutral and scientifically dispassionate Danish historians—nearly ten million soldiers died in battle or of wounds; probably two or three million soldiers were permanently disabled. Yet we were killing only by retail, where in "the next war" we shall kill by wholesale.

The same late war, according to those same Danish statisticians, cost thirty million more human beings—mere civilians—"who might be living today." Yet taking Armageddon by and large, the weapons were deliberately turned against civilians with comparative infrequency. Declining birth rates account for a part of those thirty millions. The rest, for the most part died of the "accidents," of such warfare as we waged. If we except the Armenian massacres, we find that only a small fraction of the total went to their graves through attacks aimed directly at their lives—as in the atrocities of the Hungarians against the Serbs, the Russians against the East Prussians, the Germans against the Belgians; or in attacks aimed indirectly at their lives—as in the submarine sinkings and air raids. Most of them died just because they were in the way of war—died of malnutrition in the blockaded countries, of



Estimated Loss of Soldier Lives in Recent Wars.
700,000
AMERICAN CIVIL WAR
184,000
FRANCO-PRUSSIAN WAR
10,000*
SPANISH AMERICAN WAR
9,980,000
WORLD WAR
*This figure is only an estimate. The reported loss of American lives was 2426. Figures showing loss of Spanish soldiers have not been found.

starvation and exposure in the great treks away from invading armies. But now we are to have killing by wholesale instead of retail; and killing, unless I miss my guess, aimed directly at civilian populations.

So much for civilian lives in "the next war." What about soldier lives, when we come to kill by wholesale instead of by retail? The answer involves a discussion of military weapons, tactics and strategy in "the next war."

I have not yet discussed the tank. Britain contributed that improvement, as Germany contributed gas. It involved the combination of one device almost as old as warfare—armor—with two devices borrowed from the arts of peace—the gasolene engine and the caterpillar wheel. It was an instrument of the offensive in that it gave men and guns greater mobility; it was defensive in that it protected soldiers and their weapons as they advanced into the enemy's territory. The British employed their tanks, as the Germans their gas, timidly and experimentally in the beginning. The wholesale use of tanks at the Somme in 1916 would have won the war. The munition makers, in the two years between the Somme and the Armistice, somewhat improved this new weapon. The early types could advance only four or five miles an hour over ordinary rough ground—just the pace of a man at a brisk walk. The improved types could make ten or twelve miles an hour—practically, the speed of cavalry in

action. The tanks of the Somme carried merely machine-guns. Many of those used in the Battle of Liberation were armed with standard-calibre field-guns. Practically, there is no limit to the possible size of tanks. Munitions designers are preparing to build them bigger and bigger, just as naval designers have built warships bigger and bigger—from two hundred-ton caravels which fought the Armada to the 20,000-ton dreadnought. The "land battleship" will doubtless grow in bulk until expense sets a limit. And now, military experts are considering a new possibility of tanks. If a submarine warship may be rendered water-tight, so may a tank be rendered gas-tight.

Poison gas, as I have repeated even to weariness, seems to be the killing weapon of the future. However, the explosive shell is by no means out of date. It merely becomes more or less of an auxiliary to gas. Gas cannot batter down intrenchments and fortifications, destroy buildings, puncture masks or air-proof tanks and fortresses. The explosive shell will still blast the way; the gas will for the most part do the actual job of killing. Explosive-projecting artillery will either be encased in tanks or, when it takes the open, generally mounted on the caterpillar wheel, which gives it far greater mobility, even over rough country, than the swiftest horse-drawn artillery. Designers of tanks and modern gun-carriages are of course studying to increase their speed. We may reasonably expect that even the heavy artil-

lery will be able, by "the next war," to go twenty or twenty-five miles an hour. Hitherto, armies have needed roads in order to advance. But the caterpillar wheel makes artillery comparatively independent of highways.

These, then, will probably be the tactics of the next war on land, provided that we make no great basic discovery in the art of killing, but only improve up to their best possibilities the instruments we have and know. The better to imagine the scene, let us repeat the situation of the last war, and imagine a thoroughly-prepared Germany attacking and trying to invade a thoroughly-prepared France.

The attackers will probably dispense with a declaration of hostilities, following the precedent established by the Japanese in their war against Russia. "Wars will no longer be declared," says the Colonel Fuller so often quoted above, "but like a tropical tornado there will be a darkening of the sky, and then the flood. To dally over the declaration will be considered as foolish as a Fontenoy courtesy—a wave of a plumed hat—'Gentlemen of France, fire first!'" Germany will start from her frontier an army of tanks, big and little, gas-proof, their guns provided with gas shells to kill, with explosive shells to open the way for killing. They will be backed by the heavy artillery on caterpillar trucks. The French will probably have a defence ready for this form of attack. Across their frontiers will stretch a line of retorts capable of setting up a lethal cloud four

hundred miles long—"from Switzerland to the sea." At the burst of hostilities, the French will loosen this defence; if it works perfectly, they will have leisure to mobilize. The Germans may elect to advance their force of gas-proof tanks through this cloud; they may wait for it to dissipate; they may have means to drive "alleys of immunity" through it, and so permit the passage of their forces. What method they try depends largely on the future of infantry; and that is still a moot point.

Certain optimistic soldiers have registered the belief that the dense masses of infantry, which have been the backbone of all previous modern wars, will disappear from the new warfare. Tanks, the cavalry of the future, will win and lose battles. It will be impossible for any nation to manufacture enough tanks to contain its whole mobilizable force; there is not so much steel-making capacity in the world. Therefore, we shall come down again to comparatively small professional armies of experts.

Most soldiers with whom I have talked do not endorse this view. They think that nothing will ever wholly displace infantry. Artillery was king of battles in the late war; all national resources were bent toward making guns and still more guns, shells and still more shells. Yet the masses of infantry remained; the General Staffs were shrieking not only for more guns, but for more men. You wage war to occupy positions and territory; nothing can finally seize and hold positions and territory but great

bodies of armed men. These soldiers to whom I have talked believe that this old, basic rule of warfare will not change in the next war, any more than it changed in the late war. The infantryman may, however, abandon his rifle, and carry instead the shorter-ranged but far more deadly gas-grenade—though even the passing of the rifle, in its multiplied form of the machine-gun, seems doubtful.

There is some question whether these masses of infantry will come directly to grips with each other. But that does not mean that they will not be killed "by wholesale, not by retail." They may be held back until the machines of war have stamped out resistance, and then brought up merely to hold the territory; but they will be constantly under attack from the air.

For even before the tank-army starts toward that belt of lethal mist which marks the frontier, the air-fleets will be on their way. I have shown how unmanned aeroplanes may be directed by wireless, and so become projectiles of unimagined range and calibre. Such fleets, and other aircraft armed with machine-guns, high explosive bombs, gas-bombs, will search out the masses of waiting infantry. The defenders will fight these fleets with their own aeroplanes; while the tanks are waging war on solid land, the aircraft will be engaged in a wholesale version of the retail air-holocausts which we knew in the late war. Whenever squadrons of these attacking aeroplanes get through to their objective,

whether bodies of soldiers or towns, they may make even the slaughter of Verdun seem by comparison like bow-and-arrow warfare.

Such a war, probably, would not last long. That is not a certainty, however. One can imagine a drawn first attack; a situation where after incredible slaughter and destruction on both sides, the belligerents would settle down to a war of gas on the frontiers and of aeroplane raids on the towns, while each side strove to manufacture enough munitions for a decisive victory. However, even a war of a few weeks or months would be enough. It would probably roll up at least as large a score of killed and maimed soldiers, of property destruction, as the late war of unblessed memory. It would probably kill many more civilians.

What of the defence—less importantly against air-bombs loaded with tons of explosive, more importantly against poison gas? Now, you must defend not only armies but citizens of towns, not only soldiers but the weakest girl baby. Usually, when a new weapon is introduced into warfare, some time passes before men invent an adequate defence. The knife, carried in the hand or mounted on a shaft, dates from prehistoric times; we were well advanced into historic times before body armor became good enough to turn the edge of a knife. The best defence against gun-fire—burrowing in the earth—though long known, was not fully worked out and universally applied until the late war. The mask

formed a pretty good defence against the first poison gases; its difficulties and imperfections I have mentioned before. But the German mustard gas, the American Lewisite gas, attacks the skin, the one producing bad burns, the other fatally poisoning the system. To protect the individual against such attack there are envisaged at present two methods. The skin of the whole body may be greased with an ointment containing an antidote for the poison. The British were preparing, when the Armistice came, to adopt this defence for their armies against German mustard gas. But this was recognized as an imperfect defence. After your greased troops have for a few hours wallowed in the trenches or endured a rainstorm on the march, the ointment is rubbed off or washed off in patches. Better, if it could be done, would be a protective, chemically-treated suit with gloves and headpiece, perfectly fitting to the mask—in other words, a mask extended to cover the whole body. This may be tried, for armies. After all, they must have uniforms. Finally comes the method of sending the advanced forces to action enclosed in gas-proof tanks.

But when you consider these methods of defence for civilian populations, you encounter special difficulties. In the next European war, shall we have all the inhabitants of Paris living in a coating of protective ointment, the mask ready to hand? Every line officer knows how hard it was to make disciplined soldiers keep on their masks in time of danger.

To make civilians keep themselves greased, to make them assume their masks promptly and intelligently in the event of a general killing raid over London or Paris, we should have to render universal military training really universal, and begin it not in the schools but in the cradle. The same objection—with expense in addition—would apply to the provision of "anti-gas" suits for all civilians in the great cities.

The gas-proof tank, a military improvement now virtually accomplished, points the way to the perfect defence. Colonel Fuller imagines "centres of defence"—fortresses, or something like them, rendered gas-tight, wherein you may keep your reserve forces, to which your tanks will return for repairs and replenishment of supplies. We can reconstruct our great cities so as to furnish for our civilians "centres of defence." That was done imperfectly in the late war, when in constantly-raided towns such as Venice the authorities banked the deep cellars with sandbags, thus turning them into dug-outs like those used by the troops. However, cellars will never form a defence against sinking, lethal, cell-killing gas like Lewisite and its probable successors. The shelters must be large enough to accommodate the people of a whole city; they must be deep enough in the ground to resist the enormous explosive power of the great, new bombs; they must be gas-proofed, either by rendering them air-tight and furnishing oxygen to keep the inmates alive, or by providing ventilators

which make the outer air pass through an antidote. They must be as easily accessible as a subway—even more accessible. This virtually involves rebuilding modern cities, if the inhabitants expect to survive a war. It is absurd, of course.

Unless some General Staff in Europe is hugging a deep and sinister secret, we have not yet found the killing ray. That lies beyond the present frontiers of science; its discovery involves pioneer work. If it comes, it may change and intensify warfare in many ways which we cannot at present conceive. But warfare by disease-bearing bacilli is already preparing in the laboratories. Here, for example, is one method which I have heard suggested and which, I learn from men of science, seems quite possible: Find some rather rare disease, preferably one which flourishes in a far corner of the world, so that people of your own region have no natural immunity against it, just as the American Indians have no immunity against measles. Experiment until you find a good, practical serum which may be manufactured on a wholesale scale. Cultivate the bacilli until they are strengthened to that malignant stage with which the recent influenza epidemic made us familiar—that can be done with some species of bacilli. Innoculate your own army; if necessary your own civilian population. Then by night-flying aeroplanes, by spies, by infected insects, vermin or water, by any other means which ingenuity may suggest, scatter the germs among the enemy forces. In a

few days, you will have a sick enemy, easily conquered. It takes time to discover a specific or a serum for a new disease. The mischief would be done long before the laboratories of the enemy could find a defence for this especially romantic and valorous form of battle. As germ warfare is at present conceived, it would be directed against armies alone. But any one who followed the late war knows what human chains bind the troops in the trenches to the general population. With almost every one ministering in some capacity to the army, soldiers and civilians are inextricably mixed. Armies simply could not be quarantined. Among the possibilities of the next war is a general, blighting epidemic, like the Black Plagues of the Middle Ages—a sudden, mysterious, undiscriminating rush of death from which a man can save himself only by fleeing his fellow man.

Then—there are easily cultivated, easily spread, diseases of plants. What about a rust which will ruin your enemy's grain crop and starve him out? That method of warfare has been suggested and is now being investigated.

So much for the direct effect of the next land war upon human life, and especially upon civilian life. Before I leave the subject, however, I must go into naval operations, of which I have hitherto omitted mention. The submarine, in the hands of the Ger-

mans, proved its distinct value. Many naval men say that the Germans made the same mistake with their submarines that they did with their gases, and that the British did with their tanks. They did not realize the power in their hands. Had they begun the war with as many submarines as they manned in 1917, had they stuck from first to last to their policy of sinking without warning, they might have starved out England and won. The submarine grew mightily in speed, in cruising radius, in offensive power. The German U-boats of 1914 were as slow as a tub freighter; they could make only short dashes from their bases; they depended almost entirely on their torpedoes. Those of 1918 were almost as fast on the surface as an old-fashioned battleship, they proved that they could cross and recross the Atlantic on their own supplies of fuel, they mounted long-range five- and six-inch guns. That much greater improvement is possible, all naval designers agree. Certain naval architects hold that virtually all warships of the future will be capable of diving and traveling concealed under water—the submersible dreadnought. I shall not go into the present controversy between the experts who would stick to the surface dreadnought and those who believe in scrapping fleets and designing only submersibles. I, the landman, will not presume to judge between nautical experts. But I notice that those who adhere to the theory of surface fleets

qualify their statements with—"for the present." They seem to believe that it will come to submarines or submersibles in the end.

We all know from the expression of the late war how perfectly the ocean protects submarines. Germans have told me since the Armistice that at no time did the Imperial Navy have more than fifty of these craft cruising at once; usually there were only about twenty-five. Against them, the Allies were using at least half of their naval resources; thousands of craft, from giant dreadnoughts to swift little chasers, mobilized to fight imperfectly less than fifty of these deep-sea assassins! You can attack them with other naval vessels only from the surface. That "submarine cannot fight submarine" is a naval axiom. In the next war, a few hundred submersibles of the new, swift, powerful type could almost undoubtedly accomplish what Germany failed to accomplish in 1917 and 1918—establish an effective food-blockade of England or of any other region dependent upon overseas importation for its bread and meat.

And whoever starts such a campaign will unquestionably heed the plea of "national necessity" as did Germany in 1917-1918: abrogate the old sea-law which compelled attackers to warn ships about to be sunk, and strike out of the darkness and the sea-depths. For the lid is off.

So we may add to the possible death-cost in the

next war not only malnutrition but actual starvation "by wholesale."

Remember those Danish statistics. Ten million soldiers in arms died in the last war; and thirty million others "who might be living today" are not living. War on civilians was not yet a generally acknowledged fact; it was only a practical result. In the next war, it will be an acknowledged fact. The civilian population, I repeat once for all, will be an objective of military necessity—fair game.

It would not be, could not be, if we fought only with the old, primitive weapons, saw with our own eyes the effect of our blows. During the invasion of Belgium, a friend of mine stood beside a German private playing with a little Belgian girl. "Our discipline is perfect," said the officer. "You see that soldier. He likes that child. He has toward her humane sentiments. Yet if I ordered him to run his bayonet through her, he would obey without an instant's hesitation." Now personally, I doubt that. The man in question might have obeyed; I do not believe that the average German soldier would have obeyed—slightly brutalized though he was by "the system." There were German atrocities in Belgium —I can testify personally to that—but they did not happen in that way. Contrary to a rumor widely circulated and believed by many Americans as gospel, the Germans did not cut off children's hands.

But the new warfare takes advantage of the limits of human imagination. If you bayonet a child, you see the spurt of blood, the curling up of the little body, the look in the eyes. . . . But if you loose a bomb on a town, you see only that you have made a fair hit. Time and again I have dined with French boy-aviators, British boy-aviators, American boy-aviators, home from raids. They were gallant, generous, kindly youths. And they were thinking and talking not of the effects of their bombs but only of "the hit." If now and then a spurt of vision shot into their minds, they closed their imagination—as one must do in war.

CHAPTER VI

WAR AND THE RACE

So much for civilians. Now let us turn our imaginations again upon those ten million soldiers dead in the last war, and the unestimated millions in the next. Let us forget the obvious; let me forget it who have seen war—the gray-green streak down Douaumont Ravine where lay tens of thousands of German dead, the rib-bones sticking everywhere out of Vimy Ridge, the wave of moaning from the three thousand wounded and dying in the Casino Hospital at Boulogne. Let us remember that all men must die, and consider the thing cold-bloodedly from the standpoint of the particular race which draws the sword, and of the whole human species. We shall find, then, that the chief loss of the late war was not the hundreds of billions of dollars of property value destroyed, nor yet the thirty million civilians "who might be living today," but the ten million soldiers.

From the pacifist literature which preceded our entrance into the European War, three books stand out in memory. Jean Bloch, a Pole, maintained that war could not be; the horrors of modern warfare

were so great that men would not long face them. Events discredited Bloch; we found unexpected reservoirs of valor in the human spirit. Every week, along the great line, bodies of men performed acts of sacrifice which made Thermopylæ, the Alamo and the Charge of the Light Brigade seem poor and spiritless. Normal Angell, writing from the economic viewpoint, predicted not that war could not be, but that it would not pay; the victor would lose as well as the vanquished. Events so far have tended to vindicate Norman Angell's view; perhaps the next ten years may vindicate him entirely. The third work, less known than the others, came out of Armageddon unshaken. It is Dr. David Starr Jordan's "War and the Breed."

Jordan is an evolutionist, and looks at all society from the viewpoint of the so-called Darwinian theory. The reader may belong to a sect or a scientific creed which rejects evolution. But he need not be a Darwinian to accept Jordan's argument. He need only believe—I assume every one does—that the characteristics of ancestors are transmitted to their offspring, that strong men and women breed strong descendants, that weak men and women breed weak descendants. And Jordan maintained that a general war, fought by conscript armies under modern conditions, would set back the quality of races for centuries—that it would be a gigantic accomplishment in reverse breeding.

This is how it works: if you are a grower of live-

stock, trying to produce the champion horse or cow, you select from your colts or calves the finest specimens, and breed them; the others you slaughter or sterilize. The average cow new-caught by the barbarians from the wild herds of the European steppes probably gave only a gallon or so of milk a day. We have cows which give their dozen gallons of milk a day; and they have been evolved from the wild steppe-cow by nothing else than this long process of selective breeding. Now if it were an object to do so, breeders could take their herds of big, strong, twelve-gallon Holsteins and breed them back to the scrubby little one-gallon-cow. They need simply to reverse the process—make it impossible for the fine specimens to breed, and produce their calves, generation after generation, from the scrubs.

Modern war—conscription plus increased killing power—does exactly this with the males of the human species. You introduce universal service. Every young man, usually at the age of twenty, is drafted into the standing army for a service of two or three years. Gathered in the barracks, these conscripts are examined. Those not fit for military service, on mental and physical tests, are thrown out—in other words, the deformed, the half-witted or underbrained, the narrow-chested, the abnormally weak-muscled, the tuberculous—the culls of the breed. These culls are free to go their way, to marry if they wish, to become fathers. The rest are generally forbidden to marry until they have performed their

term of "first line" military service. Scientifically these men are selected as the flower of the nation. The term of first-line service completed, the young man at the age of twenty-two or twenty-three goes into the first reserve. He must take part annually in certain manœuvers; otherwise he is free to work and to marry. At the age of twenty-six, twenty-eight or thereabouts, he is passed on to the second reserve. At about thirty-five, he becomes a "territorial" and remains in that classification until he is about forty-five, when his military duty is supposed to be done.

"Fighting age is athletic age," say British soldiers. I do not have to tell Americans, a sporting people, that the best days of the average athlete, especially in sports like boxing or football which require intense effort and physical courage, come in the early twenties. Those first-line troops are the best troops.

Moreover, they are under arms when war breaks; they do not have to be gathered together, redrilled and redisciplined. So they go first into battle; lead all the early attacks; form generally the advanced forces all through. The second line, almost equally valuable, almost as much used, consists of men in the first reserve; and so on, until we get down to the territorials, the men between their late thirties and their middle forties. Theoretically, these "old" men are not supposed to get into action at all except when the necessity grows desperate. They

guard roads and bridges, dig reserve trenches, garrison captured territory, perform the hundred and one varieties of labor which an army requires behind its line.

When all the statistics of the war are compiled and classified, their graphic chart will look like a pyramid. They will show that the losses bore by far the heaviest on the ages between twenty and twenty-five; they shaded off until in the ages between forty and forty-nine they became almost negligible. *

Here is reverse breeding on a wholesale, intensive scale. The young, unmarried men go first to be killed; are most numerously killed through the whole war. They are the select stock of their generation; and practically, not one has fathered a child. Their blood is wholly lost to the race. Next come the men in their middle twenties. Some of them have married since they left the first line, and some have not. It is doubtful if they average more than one child apiece when their turn comes to die. So it goes on, class by class; smaller losses and more children, until we come to the Territorials of forty-five. In that category, the losses of life are proportionately very small, and if we study vital statistics, we find that men of this age have had about all the children they are going to have. But all this time

* Forty-five years was the usual limit of military service; though for a few months during 1918, the British stretched conscription to fifty. But many French and German Territorials who entered the war aged forty-five, were kept in the army until the end; and were therefore forty-nine in the year of the armistice.

the culls of whatever age, the men exempted because they are below standard, are living out their lives and fathering children.

In our own draft, we proceeded on the European plan, calling to arms the men between twenty-one and thirty, and generally exempting the married. That age was set largely to get the men of best fighting age—"athletic age." But we were moved by another consideration, which showed itself in the exemption of married men. We wished to minimize human grief and human hardship. If an unmarried boy of twenty is killed there are only his immediate blood-family to mourn him. A married man of thirty-five has in addition a wife and children. Moreover, if he goes to the war in the ranks, he must leave his wife and children virtually to shift for themselves. Great Britain recognized the same principles when, in her advance to universal conscription, she took the young before the old, the unmarried before the married.

Humane and beautiful as well as expedient, all this; yet from the racial point of view, unscientific even to immorality. Better, far better, would it be to begin at the other end of the scale, mobilizing for first-line troops the men between seventy and sixty, for the second-line those between sixty and fifty, for Territorials those between fifty and forty-five. With these old men the race, as such, has little concern. They have mostly fathered their children, done their duty to the strain.

Nature does not care in the least what becomes of the plant after it has produced its seed and the new crop is growing. If, allowing war, we were conducting it scientifically for the best interests of the race, the slogan of conscription would be not "single men first" but "grandfathers first." Of course, this is ridiculous. But it seems to me that whenever we carry out any aspect of modern war to its logical conclusion, we arrive at the ridiculous.

The older wars of modern times were not conducted by conscription, as we know it now. The rank and file, as far as we can read the records, consisted very largely of the dregs of the population who had been forced into the army by press gangs. There was a sprinkling, however, of young, vigorous youths who went to war for the adventure; there were organized bodies of soldiers of fortune who hired out as mercenaries, and who must needs be sound physically. Occasionally, too, we find a body of sturdy peasantry like the English yeomen who followed the lords of the land to war. There was, however, no selective conscription, no careful medical examination to reject the culls of the blood and send the best to slaughter, usually no rule of "single men first." Even at that, the breeding-stock killed in the old wars was probably superior to the average level of the race and species. Jordan believes that he can trace a kind of rhythm in the history of "dominant nations." The war-like race, continuously engaged in battle, reaches a point where

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it begins to go decadent, to find its force sapped. Spain, lord of the world up to the seventeenth century, holding her power by means of the famous Spanish infantry, "the wall which repaired its own breaches," suddenly faded away until by the nineteenth century she was the football of Europe. But the off-hand recruiting systems of those old days could not possibly hit the breed as hard as our modern method of scientific conscription. Just as technically-improved war has worked toward greater and greater property-destruction, so has it worked toward greater and greater race-destruction.*

The thirty million civilians deprived of life by Armageddon probably struck about the average level of the breed. Those who died of starvation or exhaustion in the great treks before the advancing hordes of the late war were below that average. These flights were primitive struggles for existence, wherein the weakest died first. Without quite the same certainty, we may say that those who died of malnutrition and the epidemics directly engendered by war were somewhat below average. That—to be perfectly cold-blooded—was a gain to the race. But the unborn—for the most part they never came into this world because their po-

* Jordan's militaristic opponents asked once for facts to support his theory. This caused Dr. Vernon Kellogg to investigate the old French records. He found that in the generation following the Napoleonic wars, the standard of height and weight for French recruits had greatly to be lowered by the military authorities. More significantly, he found the percentage of men rejected for physical unfitness greatly increased.

tential fathers were away in the trenches or dead. Those fathers were the flower of Europe, physically and mentally; meantime, the weaklings, rejected by the recruiting offices, remained at home, breeding their vitiated blood into the strain. That was a loss to the race. Probably these items just about balance one another, and we get in the civilian losses an average of the mental and physical strength of the European breed.

In the ten million soldiers lies the dead loss. Take France, who suffered most heavily of all. She had nearly a million and three-quarters men killed in action, died of wounds and "missing in action." But that does not tell the whole story. Of her young soldiers between nineteen and thirty-one years of age, about sixty per cent died in the war. While statistics are not yet compiled on this special point, it is doubtful if this glorious young company left nearly so much as an average of one child apiece. In the absolute, Germany lost more heavily, in the relative less heavily; she counts two million killed or missing in action or dead of wounds. And if we should hand over the human race to a breeder, to improve by the same methods he uses to improve a breed of horses, these are precisely the million and a half or two millions whom he would have chosen from the men of France and Germany for his purpose.

This reduction of the strength in the European breed through the selective conscription system, plus

war by machinery, is one of those situations which one can prophesy in advance with mathematical accuracy. The vital statistics of the young and adolescent in the years between 1918 and 1938, compared with those between 1894 and 1914, are going to prove the point in cold figures.

So far, wars in general have struck at the strength of the male strain alone. However much the women have been massacred, there has been no scientific selection in the choice of victims. The strength of woman has been left to war-depleted nations to renew their blood. But in the next war we shall probably do away with that archaic check on the purpose of the great god Mars. Women, as I have already shown, have proved their value for indirect military purposes, and so put themselves within the circle of destruction. Already, the general staffs of Europe are saying that the recruiting of women in the late war was irregular, hit-and-miss, wasteful. In a struggle between national resources as well as national armies, it would be far more efficient and economical to mobilize them all and select the war-workers by scientific methods, according to national convenience and necessity. All of which is true and logical. And if women are put under conscription for munitions work, for ambulance and truck driving, for the thousand and one varieties of light labor which they can perform in the rear areas of an army zone, we must proceed by the same methods which we use in selective conscription of the male ele-

ment. We shall, first of all, spare the mothers, the women who have already given their strain to the breed. They are needed in their homes for the vital business of rearing children. We shall take the young unmarried women, and choose from them by scientific test the strongest and most brilliant, rejecting the weakest and most stupid. That process was begun in the late war. The best managed munitions works gave no woman a job until medical and psychological tests proved that she had the body and brains for the work. Just as with the men, we shall send the culls back to civilian life, free to pour their inferior blood into the veins of the new generation.

In the late war, a few thousands of these superior women, chosen from among the volunteers for munitions workers and for transport drivers in the army zone, died through air raids and long-distance artillery fire. These losses were not great enough to have much effect on the breed. But they pointed the way we are going. In the next war, with its overwhelming air raids, its gases blotting out life over square miles, its bacilli, possibly its rays, munitions works and the services of the rear will be special objects of attack. There, as at the front, we shall kill by wholesale not by retail, and we shall kill our selected female breeding stock. So to the anti-social effects of the next war we must add one never accomplished before in human history: the sapping of the feminine strength in the human race, as war—even before that great reversal of selective breed-

ing which was Armageddon—seems usually to have sapped the masculine strength.

The extreme militarist declares that the highest civic duty of man is the advancement of the power and glory of his race or nation; nothing else really counts. He is confounded out of his own mouth. In the long story of races, what doth it profit a nation if during two or three generations she rules a world-circling empire as Spain did in the seventeenth century, and then sinks back exhausted and impotent as Spain did in the nineteenth? Does that make for the power and glory of the race? Yet biologic law seems to ordain that the sharp sword of the war-like nation cuts both ways; and when we intensify nature with modern science, the matter gets beyond seeming. In the idea that by war he advances the power and the ultimate glory of his race, the militarist is again mistaking appearances for reality.

CHAPTER VII

THE COST IN MONEY

So far, we have discussed mostly the direct effects of war—the last and the next—on human life. The loss of that accumulated wealth of the world which is property touches human life indirectly in a thousand ways, and is therefore of more than secondary importance. And here, we run into bewildering perplexities. What in the arbitrary terms of money the late war cost the European peoples, we already know. We know also approximately what it cost in out-and-out destruction of houses, fields, factories, mines and railroads by bombardment and conflagration. But the shrewdest economist cannot guess the final cost. It is not enough to compile the national debt, so great as to lie beyond the imagination of the average man. Those debts cannot all be paid; in some manner or other, many of them will be repudiated. The true economic loss, which cannot be repudiated, lies in the disturbance of that delicate machine of manufacture and trade by which modern industrial nations lived and worked before the great war. We see that loss every day in the absurd conditions of the third year after the Armistice. There

are three factors to industrial production—labor, machinery and raw materials. In Germany are nearly three million cotton operatives, as expert as any in the world. Standing ready to their hands is a full equipment of the most modern machinery. Half of the cotton operatives of Germany are living in idleness and semi-starvation for lack of raw material. We raise the raw material in the South of the United States—and our southern farmers are in financial difficulties this winter because they have no market for their cotton!

It was agreed in the Versailles treaty that Germany should furnish to France the equivalent of the coal-production destroyed when the Lille and Valenciennes mines were flooded. Germany has nearly fulfilled at least that clause of the treaty. At this moment (January, 1921) German coal in enormous quantities lies piled up on sidings of France, unused. France has the expert operatives; except in the devastated North, she has her intact machinery; she has a great job of building to do, and that involves steel, which is made with coal. But she cannot use that German coal just now, because a combination of adverse exchange, undermined credits and shaken confidence keeps her working men from their machines. There is in Poland and Austria that same combination of strong men and good machines, ready to work for their daily bread. But the men are starving because they have no work by which to earn food; and at the same time our farmers and

those of the Argentine are complaining that they have slack markets for their food-products.

What shrewd observers expect of the next few years in Europe may be seen in the present policy of the British Labor Party. Rightly or wrongly, the party leaders believe that they can take over the power in England. But they say frankly that they do not intend to do it now, because the next four or five years will bring such economic consequences of the late war as to swamp and discredit the faction in power. They prefer to let the "old crowd" take the onus. Possibly, the heaviest costs of the late war are still to come.

Nor can we reckon the economic losses of Armageddon without counting in the past—the thirty or forty years of intensive preparation which preceded the explosion of 1914. During that period, when chancellories kept the peace by the old-fashioned system of checks and balances, Europe was traditionally an armed camp. Economically, it was in a state of perpetual warfare. National wealth grew in this period, but national expenditure on armies and navies grew faster. In France, which for various reasons we may study most easily, the military and naval budget increased from fifteen to twenty per cent during each decade; and the indirect appropriations for the army, as for example in the item of strategic railways, even faster. Directly and indirectly, she was by 1905, ten years before the great war, spending between two hundred and ten and two

hundred and twenty-five million dollars annually on her army and navy. At the same time, she was paying about a hundred and fifty millions annually in interest on the debts of old wars—she was still financing the campaigns of the two Napoleons. Such figures mean nothing to the average mind; but here is a basis of comparison. France is strongly centralized. Most of her popular education is financed not by the city or county as with us, but by the national government. And in the years when it was paying more than two hundred millions for the next war, a hundred and fifty millions for old wars, the national government spent on education about forty-six millions.

Now this was almost dead economic loss. In the ordinary processes of industry, part of the receipts at least are going to increase the world's wealth. Take for example the ultimate destiny of a dollar paid into the cotton manufacturing business. Most of it buys someone bread and meat and shelter and clothing. But just so many cents or mills of that dollar buy factories, machinery, swifter transportation—something which will make more wealth and still more wealth. It is like a crop of which the greater part is eaten, the lesser part kept for seed. The money spent on armies and navies in no wise increases the world's real wealth, even when the shells merely lie and disintegrate in the magazines, the guns grow old-fashioned in the barracks. And when

they are used, of course they are actively destroying wealth.

The war came; and it was possible under the urge of national necessity to increase taxation. All did, some more, some less. England crowded on the taxes until the man of an average middle-class income was paying before the end some forty per cent of his income. Germany and France paid less heavily at the time. Each was calculating on victory, and on making the loser pay. France won; and already she realizes that she cannot begin to reimburse herself, even though she milks from Germany her last mark. And Germany the loser—expression fails in the face of her predicament.

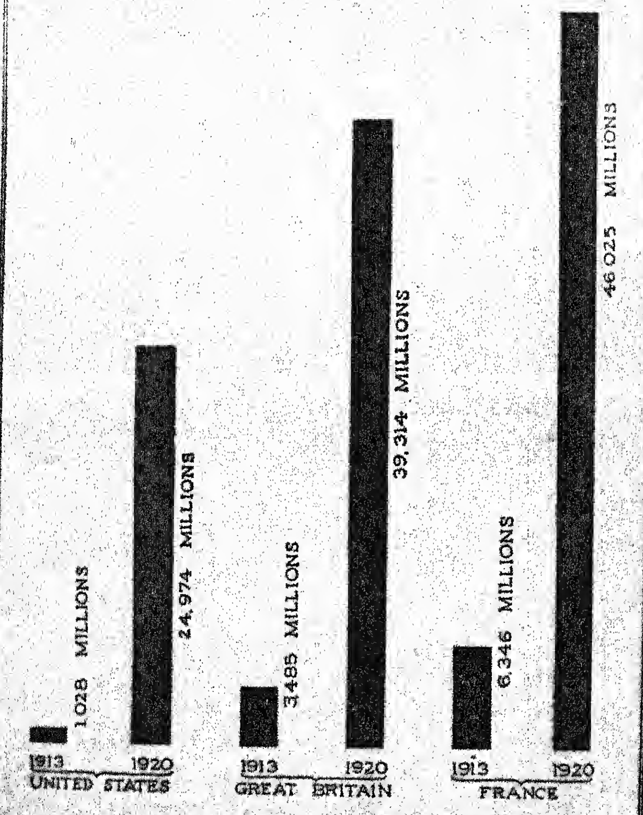
But tax as they might, the nations had at once to begin drawing on their future, asking for unprecedented loans both from their own people and from foreigners. Debts piled up beyond imagination.

Let me set down a few figures. They will not mean much to the reader, I suppose, any more than they mean much to the writer; they are too overwhelmingly big. In actual money, paid out over the counter, virtually all taken from the world's accumulated wealth, the war cost one hundred and eighty-six billion dollars. If you add the indirect cost such as destruction of property, loss of production and the capitalized value of the human lives, the sum reaches three hundred and thirty-seven billion dollars. The national debts of Great Britain

rose from three and a half billions to thirty-nine billions; of France from six and a third billions to forty-six billions; of the United States from one billion to nearly twenty-five billions.

By certain comparisons, we may arrive at an understanding of these figures. Again I will take France as the best example at hand. Her total national wealth—farms, mines, factories, buildings, railroads, canals, everything she owns—was estimated in 1920 at ninety-two and a half billion dollars. Her debt, as I have said, is forty-six billion dollars—almost exactly half her total wealth. That wealth was her heritage. When the first Gaul, long before Julius Cæsar came, cleared land on the borders of the Seine, he was creating national wealth for the France of 1920. It had been accumulating for more than twenty centuries. Now we will say that you own a factory worth, at current market rates, something like one hundred thousand dollars. There comes a period of unprecedented hard times, in the midst of which you have a fire which—since you carry no insurance—destroys the value of a part of your plant. You find that your business is worth ninety-two thousand and five hundred dollars; and that you have been forced to put upon it a mortgage of forty-six thousand dollars. Then you face another period of hard times, with money tight, markets poor, raw materials hard to get. That, in terms of business, is the situation of France. Great Britain is only a little less affected. Her national

National Debts of
United States, Great Britain & France
in 1913 and in 1920.



wealth is one hundred and twenty billions; her debt is nearly forty billions. So it goes, in greater or less degree, with Germany, Italy, the Austrian states, the Balkan states. This apart from the actual physical destruction of property.

There again we run into incomprehensible figures. I have spoken already of the growing disproportion between the cost of the cannon and its charge on the one hand and the destruction which it can accomplish on the other. Of that, Northern France stands as the living proof. France lost the most heavily in property, as she did in life. Proportionately to her population and wealth, Belgium's loss is only a little less; among the greater nations, Italy stands next. Physical destruction of property was very unevenly distributed. But it all comes out of the wealth of the world; and so interlocked are the activities of modern nations that you cannot destroy any considerable body of wealth in one region without causing disturbances in others.

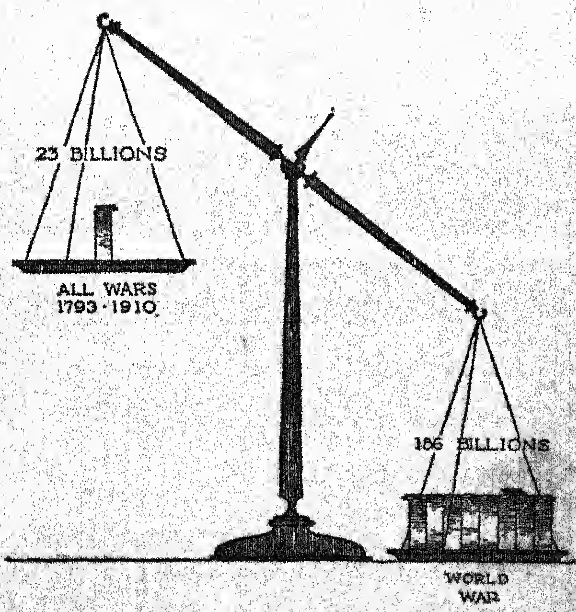
Let us abandon abstract figures and make this the basis of comparison: In 1906, the city of San Francisco was partially destroyed by earthquake and fire. A year or so later, we had a brief financial depression; there were lesser depressions in England and Germany, where insurance companies had been hard hit. And many economists said that it was all due to the loss of wealth and the disturbance of conditions caused by the San Francisco disaster.

In Northern France, about as many buildings

were destroyed—omitting those merely damaged—as there are in Greater New York; and New York has twelve or thirteen times the population of San Francisco at the time of the disaster. The region of San Francisco lost no canals, railroads, or improved highways. She was not a manufacturing city; and such factories as she had mostly escaped. But France did lose factories, canals, railways, highways in her most thickly populated country—a belt four hundred miles long, from five miles wide in Alsace to fifty miles wide north and west of Noyon. In the region merely invaded, about Lille, she lost enormous values in machines turned into scrap-iron, and eventually into shells, by the conquerers. The disaster of 1906 destroyed no agricultural land. France lost to agriculture, for at least a generation, from four to five hundred thousand acres—land with its top-soil blown to the winds, or ground into the clay subsoil. Roughly, I estimate that the destruction of visible, physical property in Northern France—to say nothing of Belgium, Italy, Serbia, Greece and East Prussia—was equivalent to twenty or twenty-five San Francisco disasters. Leaving out the direct property loss of other nations, the orgy of spending during four and a quarter years, the incredible national debts and their interest, this belt of destruction in France alone would almost account for the present disturbances of conditions in the whole world.

The war-bill of nations in peace times consists of

Cost of World War
compared with
Cost of All Wars
from 1793 (beginning of Napoleonic Wars)
to 1910



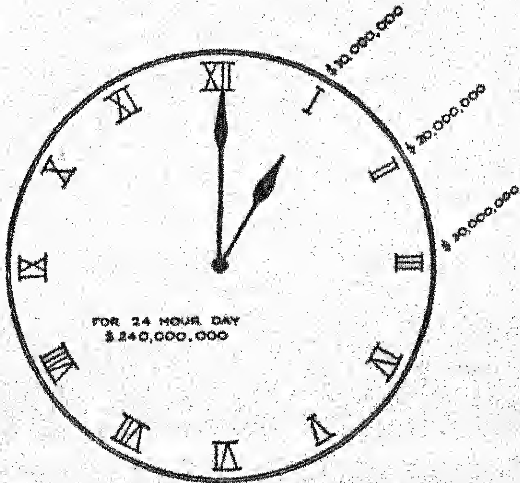
interest on the national debt, caused by old wars, plus the direct cost of supporting armament. Still using France as an example; if she spends as much on her army and navy in the period between 1920 and 1930 even as she did in the period between 1900 and 1910, her war-bill will be multiplied by about three and a half. She may get a certain amount of German indemnity. That, probably, will not be enough to restore her North and to finance her pensions; it will not go toward lightening the taxes which pay the war-bill. France, like the other European nations, was taxed in 1914 to the point of absurdity; now, she must eventually multiply the taxes by three or four. Even this calculation does not involve a sinking-fund to pay off the debt. Fifty years from now, possibly a hundred years, France will still be paying the bill of 1914-18. And this is true not only of France, but of all the other nations who fought through the great war. In hardship, toil, reduced standard of living, the next two generations will pay—or else—this is still possible—European civilization will tumble into the gulf of anarchy. H. G. Wells said to the writer, a month after the war began, "All our lives we shall be talking of the good, old days of 1913." That war-prophecy is being fulfilled.

Let us now bring the subject home. We, of all, lost the least in property as in men. We had, indeed, profited greatly in the two years and a half of our neutrality. We held, by the end of that

period, almost half of the gold in the world. Of course, we poured all that prosperity and much more into the last two years of the world war. We multiplied our national debt by twenty-four. We are beginning for the first time to know what taxation really means. We grumble at the heavy income tax; yet if we are to meet our obligations, it must continue at something like its present scale for the lifetime of this generation. Fifty years from now, we may still be paying. We experienced during the two years following November, 1918, an era of hectic prosperity—followed by a collapse, in which we are learning that war-gold is fool's gold. All things considered, we came as near as anyone to winning Armageddon. But everyone loses a modern war, the victors along with the vanquished; economically, we too lost.

Before we entered the great war, we were called a pacifist people and as such were the scorn of European militarists. Indeed, war had troubled us less than any other great people. Since our federation, we had fought only one first-class war, that between the states in 1861-65. The war of 1812, the Mexican War, the Spanish War were, socially and economically speaking, comparable only to the small colonial expeditions of Great Britain and France. Beginning with the eighties and nineties of the past century, we had built up a comparatively strong navy; by 1914, it ranked third or perhaps fourth among those of the great powers. However,

Cost of the World War during its last year



The money the World War cost for a single hour during the last year would build ten high schools costing one million dollars each.

The money it cost for a single day would build in each of the 48 states two hospitals costing $500,000 each; two $1,000,000 high schools in each state; 300 recreation centers with gymnasiums and swimming pools costing $300,000 each; and there would be left $6,000,000 to promote industrial education.

$240,000,000 was the total cost per day for all countries. It includes only direct costs, not the destruction of civil property.

Rammahesh Singh.

1st year.

our standing army was to European militarists a joke. At one period between the Spanish War and the Great War we had only twenty-five thousand regulars under arms, whereas in several European countries of smaller population than ours the standing army consisted of more than three quarters of a million soldiers; and every able-bodied man had been trained and equipped.

Yet in the year 1920, with the war over and done, with our great army demobilized and our fleets back to the business of manœuvres and visiting, we were spending the greater part of our national revenues on wars, old and new. In 1920, the proportion was ninety-three per cent.

What could our government do with this money? What could it not do!

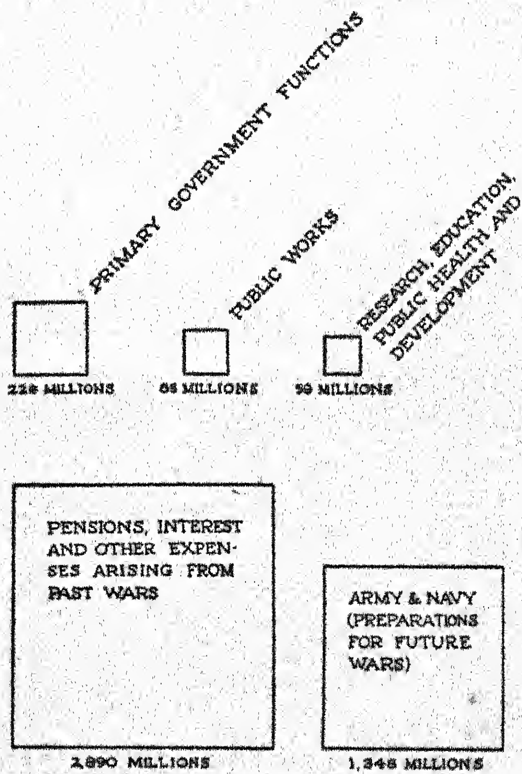
A little before the Great War, I was talking to an expert, nationally famous, on good roads. He spoke of the highways so vitally important in our great and wide-spreading country and of the staggering costs of road improvement. "We could of course pave every country road in the United States," he said, "and the economies it would introduce into transportation would make it a paying proposition in the end. But the initial cost and the upkeep—you can't possibly raise enough money. It would take, I estimate, seventy-five per cent of our Federal revenues." There you are. This "impossible" but paying proposition would take seventy-five per cent of our revenues; war in 1920 took

ninety-three per cent. We could make all the common roads of the United States like the famous main highways of France or Belgium, for the cost of our wars, past, present and future—and still have money in the bank.

In our government are a number of bureaus concerned with increasing production, fighting disease, supervising, as it seems that only governments can supervise, the agencies which conserve life and increase production. Our entomologists have reduced such plant scourges as the San José scale and grape phylloxera almost to impotence, so saving us many millions yearly; they are on their way to conquer the boll weevil in cotton. Our ichthyologists have plans, now only partly realizable from lack of money, greatly to increase our fish supply. Our boards of health, under national supervision, have virtually killed yellow fever and smallpox, greatly reduced malaria and typhoid fever, are beginning to attack those "social diseases" which are next to war the great scourge of the human race.

Go into any of these Washington bureaus and some specialist, some practical dreamer struggling along at a salary running from fifteen hundred dollars to three thousand dollars a year, will tell you what "his people" could do to multiply production and improve human conditions, to lengthen and fortify life, to increase the beauty or usefulness of the world "if we only had the money." But they haven't the money. For these activities, the Gov-

Actual expenditures of the United States for the fiscal year 1919-20 (Loans to European Governments not included.)



ernment grants less than one per cent of the National revenue. In 1920, the existing army and navy absorbed thirty-eight per cent; and the whole war bill, as I have said, was ninety-three per cent.

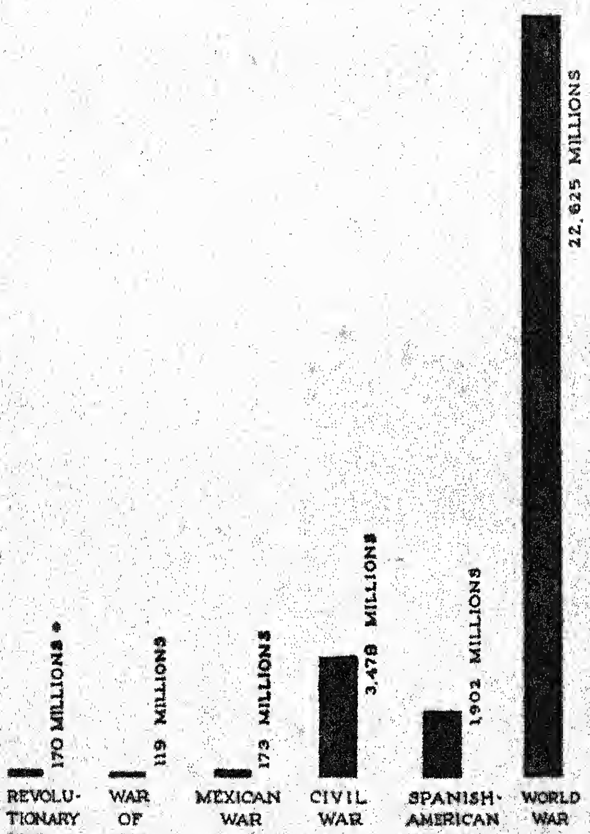
What could we, "the pacifist nation of the world," not do with that ninety-three per cent? You remember the Roosevelt Dam in the Far West—hundreds of thousands of acres transformed from desert to fertile farms with a little government money. Millions more are awaiting the same transformation. Here is a chance to increase our true national greatness; but the government, of course, cannot undertake that because it cannot spare the money. Our forests are shrinking; we feel the effect in the rising price of lumber, the shortage of wood-pulp. We need to reforest on a large scale; that work, European countries have learned, can be most cheaply, easily and intelligently done by a central government. We are reforesting, if at all, on a microscopic scale; we are barely keeping down fires. All because we cannot afford the money from our national revenues. Wars, past, present and future, cost too much.

Then comes the period when our long preparation for new wars becomes—action. Then arrives an orgy of spending without return—and a greater war-bill for the future.

But we are treating of "the next war." By that we mean of course not a little "settling" war such as the present British and French campaigns in the

Near East, the skirmishes along the Russian border, nor yet the minor colonial expeditions. We mean a struggle between industrial nations, thoroughly prepared. In terms of economics, will that struggle be less costly than the last, or more?

Cost of Wars to the United States



* National debt at end of war.

CHAPTER VIII

ECONOMICS AND THE NEXT WAR

IN all the major wars of the past three centuries, one traces a certain progression from armed contest between individual nations to armed contest between alliances. Sometimes indeed, two hostile nations are "isolated," as when the rest of Europe managed to keep out of the war between France and Germany in 1870. But the tendency remains. And there is a reasonable cause for this—the increasing speed and facility of transportation, the increasing interdependence of nations. In 1914, according to an authority on transportation, any man was in terms of time eleven times nearer to any given point in the world than in 1814. There you have one explanation for the world-wide spread of the Great War.

If things in this "new world" are to go in the old manner, the chancellories of Europe will seek to keep an impermanent peace, will give themselves a "breathing-space between wars" by forming alliances. With the major nations struggling even for greater advantage, with the smaller nations in growing fear of their own defencelessness, the alliances

will naturally tend to grow greater and greater. "In the next war there will be no neutrals," some say; almost certainly, in the next European war. Spain, Switzerland, Holland, Scandinavia, Greece, will be afraid, remembering Belgium, to remain out of alliances. Indeed, Belgium has pointed the way. A recognized neutral up to the Great War, she has renounced the principle of neutrality, and allied herself with France. Probably the great European powers will draw in the Orient actively—Japan's part, China's part in the late war were merely passive. For the world-machine tends to become ever more complex, and nations ever more interdependent. The swift airship is here; if a man is eleven times nearer any given point than he was in 1814, soon he will be twenty times nearer.

Can we stay out of the next general war? We could not stay out of the last. We are passing from a stage where we depended for foreign trade mainly on raw materials, whose sale does not need to be "pushed," to the industrial stage. Increasingly, our exports will consist of manufactured goods. Foreign markets will be to us not dumping-grounds for short seasons of overproduction but real factors in our national prosperity. And foreign markets for manufactured goods need cultivation, even forcing. With our unrivalled wealth, we shall store up surplus capital, which will find more attractive returns in undeveloped regions at home. That is happening already. Since the war, hundreds of millions, per-

haps billions, of American dollars have been invested in new, promising commercial fields abroad. So, if we play the game as we find it, we shall enter the circle of "financial imperialism" and find ourselves in some way much more closely affected by the next war than we were by the last, and correspondingly under a greater urge to enter it as belligerents.

The spread of the next war may conceivably be limited by diplomacy as was the war of 1870; even so, the next one after that probably cannot be limited; and all our "proud isolation," our tradition against entangling alliances, will not keep us out.

The Great War, considered in terms of economics, began not in 1914 but in 1871, when the French and Germans signed the Treaty of Frankfort—when the European nations began to increase their standing armaments. In the same sense, the next war began when, after the Armistice of 1918, the great powers kept up their armies, started experiments with more efficient but more expensive ways of killing. It will be war by machinery from now on, not war by hand. And machine-work requires a much greater initial outlay of capital than hand-work. Naval warfare has always been war by machinery. It will not be necessary for me to prove by figures the greater cost of a navy, in proportion to the number of men employed, than of an army. That is going to be changed. The tank and the aeroplane have come—air-machines and land-machines, equivalent to the destroyer, the submarine

and the battleship, which are sea-machines. Of course, a big tank can whip a little tank just as a big man can whip a little man. There is no more practical limit to the size of tanks than to that of naval vessels. The same rule probably holds true of aeroplanes. Consequently, as soon as the European powers begin to wriggle out of their present fix, we may expect them, with what margin they have, to begin a race of armament more expensive in proportion to their resources than the race of 1871-1914. The tank of today may be compared to a caravel. We shall have the destroyer-tank; then some nation will come along with the cruiser-tank, and the others must follow or underwrite defeat. And so on, up to the dreadnought tank—a gas-proofed fortress on caterpillar wheels, perhaps as complex and expensive as the sea-dreadnought. And if one alliance increases her fleet of land-dreadnoughts from a hundred to a hundred and twenty, from a thousand to twelve hundred, the rival alliance must let out another notch and follow. You may, if you wish, translate all this into terms of aircraft, and the economic result will be the same.

In the last war, nations learned that they must bend every resource, and especially every industrial resource, to victory. But some of them learned it rather late. Even Germany was for a long time manufacturing and exporting to the adjacent neutral countries such commodities as machinery. Later, in the fierce stress of the war, Germany turned all her

machine-factories into munitions factories. England went on for nearly two years with a business-as-usual policy before she learned she had better make munitions her sole business. There can be no such dalliance in the next war. "It will not be declared; it will burst." Upon the promptness and speed of the initial thrust may depend victory—then or later. Not only must the magazines be always full, the tanks and aeroplanes always in complete commission, the gas retorts always charged; but you must have your factories always ready for an immediate change. You must be prepared at the shortest notice to turn your dye-and-chemical works into poison gas works, your sewing-machines and typewriter factories into factories for shell-parts—and so on through a thousand industries. This requires an industrial readjustment obviously expensive, still more subtly expensive.

When the war comes, you start war-work not desultorily as in 1914, but full speed from the mark—not at a five per cent scale gradually increasing, as in 1914, but as near as possible to a one hundred per cent scale. Your whole population has been mobilized, perhaps partly trained, in advance. Your young woman knows her place in the factory and reports at once to the foreman, just as your young man knows his place in the ranks and reports at once to the sergeant. The process of turning the whole national energy from wealth to waste begins at once, full power. The next war may be shorter

than the last; it can scarcely, at this intensive pace, be less costly.

Concerning the actual destruction of physical property, one may speak with less certainty. It all depends upon the larger strategy. I have suggested the elimination of all life in such a city as Paris—or New York—as a possible result. That could be accomplished by such a gas as Lewisite. Now Lewisite whirled in a lethal cloud over Paris would not greatly injure property. When at length the poison was dissipated, the Opéra would still be there and the Louvre and the great railway terminals and the factories—a little corroded perhaps, but still usable after you cleaned out the corpses and tidied up a bit. So perhaps a better way of breaking up the "resistance of the rear" would be to exterminate not the human Paris but the physical Paris. That could be done in one gigantic conflagration started by inextinguishable chemicals dropped from a few aircraft. The method is practicable even now, in the infancy of chemical warfare; and the military chemists of Europe are experimenting further along these lines. Such a campaign would of course not be confined to Paris; although Paris as a centre for the brains of war, as the most vital knot in the railway web and as a great factory city, is eminently important. It would be aimed also at Lyons and St. Etienne, great manufacturing cities, at Marseilles, Cherbourg, Havre and Bordeaux, the great

ports, at a hundred little cities which do their part in making munitions.

In such a campaign of conflagrations, the loss of life would necessarily be less than in a killing attack with gas. But possibly not much. Imagine Paris suddenly become a superheated furnace in a hundred spots; imagine a swift rush of flame through every quarter; imagine the population struggling, piling up, shriveling with the heat; imagine the survivors ranging the open fields in the condition of starving animals.

Such a campaign could in a few weeks nearly equal the property-losses of the Great War; especially if the defenders, whom I have imagined to be the French, retaliated on the attackers—say the Germans—and burned Berlin and the Rhine towns.

So far as we can see now, gas will probably be the standard weapon of the next war. High explosive will still be used on an extensive scale; but it will be auxiliary to the new killing instrument. It is unlikely that there will be a locked trench-line and a steady bombardment lasting for years. Consequently—ignoring the possibility of great conflagrations—we may hope for a smaller loss in the item of buildings. On the other hand, the bill will probably show a larger item for destroyed fields—agricultural wealth. The struggle just finished was the first in history where any considerable area of land was ruined for cultivation. Now it is a prop-

erty of the new poison gas that it sterilizes—not only kills cells but prevents the growth of cells. Concerning one successor of Lewisite gas an expert has said: "You burst a container carrying a minute quantity of the substance which makes the gas, at the foot of a tree. You do not see the fumes rise; it is invisible. But within a few seconds you see the leaves begin to shrivel. While we are not quite certain, we estimate that land on which this gas has fallen will grow nothing for about seven years." In the next war,—unless we discover meantime some still more effective method of killing—clouds of such gas will sweep over hundreds of square miles, not only eliminating all unprotected life, animal and vegetable, but sterilizing the soil—"for about seven years." What were farms, orchards and gardens will become in a breath deserts. The power of its soil to produce food is the first, vital item in the wealth of nations. It would seem that this increased loss of productive land should at least balance the decreased loss in buildings.

So modern warfare, in its economic aspect, follows the same rule as in its human aspect. Now that we have renounced all pretty rules of chivalry, now that we have put brains into the business, its destructiveness ever increases. There, perhaps, lies the best chance of eliminating it from the world. The desire to create and to conserve wealth is deeply implanted in the bosom of man. Why not? The two primary forces by which a species lives are the

desire for food and the desire to reproduce. This desire springs from the primary desire for food. Someone has pointed out that the temperance reformers of the United States made little progress so long as they harped on the sin of drunkenness. Only when they touched the question on its economic side, showed that alcohol was a great enemy to wealth and production, did the prohibition movement go with a rush. In some fifty years of agitation, pacifists have dwelt on the cruelties and horrors of war—always the moral and sentimental side. Now we are learning that it does not pay. The victor may, relatively, lose less than the vanquished. But victor and vanquished both lose in the absolute. That may be the clinching argument.

CHAPTER IX

"THE TONIC OF NATIONS"

THE moral value in peace, war and military preparation can of course be treated with less certainty than the racial and economic values. You cannot measure virtue with a yardstick nor establish by statistics the comparative virtue and vice, honor and dishonor, truth and falsehood in any man or any race. Here one must rely on general observation.

Up to the great struggle in 1914-18, the militarist and the aggressive patriot had somewhat the better of the moral argument. Obviously the man who offered up his life for the welfare or glory or whatsoever of his clan, tribe or nation is doing a fine, high thing. "Greater love than this hath no man." But modern war is changing even that. Of the ten million killed in battle, the forty million under arms, comparatively few made the supreme sacrifice voluntarily. They were conscripts. They had to go and take the chance of being killed—or die with certainty against a wall. Most of these men had received their one, two or three years of military training. It had involved mental training,

designed to lash them up, when the moment of action came, to a love of war and a desire for victory. That, and the new experience, seemed to keep them in a state of blithe morale for the first few months. There is a curious, exalted state of mind about the early days of a war. All of us who dodged about the rear, immune from its hardships, nearly immune from its dangers, felt that mood. Never again shall I be so poignantly moved by the beauty of paintings, of old cathedrals, of women, of blossoming fields, as during those early days of the war. It was as though I were constantly and pleasantly a little drunk. Now the men at the front—wallowing in filth and misery, hardening themselves against instant death—felt nevertheless something of the same mood. Then it passed, as intoxication will. Thereafter, they "carried on" because they must. They had been taught it was their duty; most of them believed that; but deep down lay a rebellion against the whole principle of the thing. Boards of morale and of propaganda invented the phrase "the war to end war." The men of the trenches clutched at that. "It must never happen again"—you hear the phrase to weariness from the British ranks, the French ranks, the Belgian ranks, the Italian ranks. They did not consider themselves as men making an act of sacrifice but rather as men caught in a wheel from which there was no present escape. Germany went to war in a state of exaltation, lashed up through forty years of military prepa-

ration. But the German ranks must have felt the same; else there would have been no German revolution. Read Philip Gibbs's "Now It Can Be Told" and Henri Barbousse's "Under Fire"—tolerant observers of high intelligence and of wide experience these two—and learn how little exaltation of self-sacrifice there was in Armageddon.

Much propaganda was spilled during the war to show how, in the same manner, Armageddon profited the higher morals of the civilian population. We heard of the "flapper" who became a heroine; of the frivolous matron who put off her silks and chiffons, put on denim and went to work "in munitions"; of the selfish rich man who gave up servants and automobiles and shooting lodges to help finance the war. This was indeed a moral gain—a temporary one at least. It is good for the souls of the overfed that they fast; it is good for the souls of the idle that they go to work; it is good for the souls of the selfish that they feel the thrill of a generous, common emotion. But how large was this special moral gain? Only as large as the upper class. Every country has its submerged tenth and correspondingly its exalted tenth. The other eight-tenths do not sacrifice comfort or nourishment or leisure—at least not voluntarily. They have no margins of the kind to sacrifice. When the accidents of war drove a family ahead of an invading army to perish of hunger or hardship in the fields, when a whole population lived on reduced rations because of a

blockade—that was not a voluntary sacrifice. To take seriously the argument that such a war as we have just endured is good because people "know the nobility of self-sacrifice" is to imply that the upper class is the only class which counts.

Unquestionably, there came with the war a movement back to whatever religion the peoples of Armageddon have. But I could never feel, observing Europe during the war, that this was the highest and healthiest form of religion. With their sons in peril of death, their homes in peril of destruction, their nations in peril of extinction, people turned toward whatever God they had—to ask for something. Nor—again I speak from observation—did this special form of religion seem to survive the war.

And there was a strong back-current which censorships, both official and implied, prevented us from describing while the war was on. Whole classes of the European population threw off the ordinary moral restraints imposed by peace. The performances of a certain large and wealthy group were notorious; and once I spoke frankly on this matter to a woman of the class in question. "Oh, it's eat, drink and be merry, for tomorrow we die," she said. "Our people are doing the things they've always wanted to do. Their inhibitions are off. They feel that nothing matters any more."

At best, whatever moral force was loosed by the Great War seems to me an impermanent thing. It did not survive the Armistice. It became no part of

the moral heritage of mankind. Lord Roberts described war as "the tonic of races." He confused substance with shadow, I think. It is a stimulant, not a tonic. Most of us know the difference. Iron is a tonic; alcohol a stimulant. Iron strengthens the system; alcohol seems to give temporary strength. Iron is a permanent gain; the reaction makes alcohol a permanent loss. It is related that the Oriental alchemist who first discovered alcohol thought he had the elixir of life—and drank himself to death. The militarist mind, still primitive in its workings, still believing that things are so because they seem to be so, makes the same mistake. Regarded in the most favorable light, the state of war is a stimulant, not a tonic.

At the beginning of the late war, we heard from German, French, British and American militarists that nations grew soft through peace. China they set up as the awful example—notwithstanding the fact that war is the only practical activity for which China of the past two hundred years has shown any aptitude. Her Tai-Ping rebellion spilled more blood than any other military struggle of the nineteenth century. But do nations grow soft through peace? The late war seemed to prove quite the contrary.

During the forty-four years between 1870-1914, the Western nations of the European continent, while armed for war, had preserved peace by the concert of the powers. There were small colonial

expeditions, it is true; but those involved comparatively few men, only a little strain on the national resources. Britain's expedition against the Boers was only a second-rate war. Europe never knew a period of peace so long and so profound. When the Germans marched on France, not one in ten thousand French or German soldiers had ever experienced the buzz of a bullet past his ear. From these people grown soft through peace we might have expected cowardice, timidity—whole armies breaking at the first fire. We got unexampled heroism. It was written in the old books on infantry tactics when a body of troops lost ten per cent or at most fifteen, they became an uncertain quantity—even though you had been able to replace the losses, it was time to take them out if you could. In the Battle of the Somme, the Allied Armies regularly kept divisions in the line until the replacements numbered fifty per cent—sometimes more. Whole companies, whole regiments fought so often to the traditional "last handful" that the newspapers scarcely troubled to record such performances—they had grown too common. Study, if you want concrete proof, the record of the famous French Twentieth Corps, recruited from Paris—city men, and therefore most affected by the soft influence of peace.

Militarists have answered that universal military training accounts for this unexpected hardness. Frenchmen, Germans and Italians had been edu-

cated for war, taught to think from their infancy in terms of war; and we are dealing with a state of mind. Then what about the British? The island of Britain had protected herself by navies, not armies. Her small army was composed of volunteers. The average Englishman, Scotchman, Irishman or Welshman did not know the trigger of a rifle from the muzzle. He had never thought of war as a possibility of his life. When Britain took to the draft, she gathered in the last of these young men, ran them through four or five months of intensive training, sent them to the line. Generally such troops, as one might expect, were inferior to the veterans in military technique. They were little if any inferior in "hardness." I saw a British draft-division once literally staggering back to the rest-station. It was a time of special stress, when relief divisions were hard to find. These men had been kept in the line until nearly seventy per cent of their original strength was gone and replaced. Yet they had held firm to the end. I have shown how modern warfare under the conscription system chooses the best, takes their activity from the existing generation, their strong blood from the next generation. That is your true softening process. Nations do not grow hard through wars and preparation for wars. This is another thing which is not so, but only seems so. Armageddon affords proof that the reverse is true.

CHAPTER X

THE DISCIPLINE OF PEACE

ALL this leads up to the question of the moral factor in general military preparation—whether peace-time conscription or universal military training. Is it useful only as a means of national defence, or has it a real value for the general purposes of society? The militarists say that it has. To begin with, it inculcates obedience, and the instinct of discipline. It spreads the habits of civilization among the masses. It takes boys with round shoulders, shuffling gait, uncleanly ways, lawless manners, and makes them straight, upstanding, clean, orderly, obedient men. During the war, they showed us photographs of these awful examples, before and after taking.

Now it is true that tens of thousands of our young men, perhaps hundreds of thousands, were so transformed by army training. But we must consider averages, not exceptions. Millions of others —certainly the great majority—came from a good, sound American environment. All of them in their childhood, most of them in their youth, had practised athletic sport in some form. They presented

themselves to the drill-sergeant with fine, well-developed bodies. They knew how to keep themselves clean. They had been under the tight discipline of the modern world from the moment they opened a first reader—in school, in factory, in business. And after they left school, it was a kind of voluntary discipline making, it seems to me, for higher aims in character than any kind of involuntary discipline.

In the modern world as contrasted with the ancient we all live under strict discipline, partly self-imposed. Every morning, the reader gets up and goes at a set hour to his office or shop. No bugle wakes him; no sergeant barks out the order to fall in and go to work. If he grows weary of getting up at six or seven, he has only to quit his job. He will not be shot or jailed or publicly disgraced for that, as he would if he deserted from the army. To quit the job might hurt his career, might work privation on his family—that is all. Every morning after breakfast I sit down and write. Today, there is a dog-show in town. I want very much to go. I am not going, because I have too much work to do. So I hold myself to writing—voluntarily. Now both the reader and I are doing a thing, it seems to me, better for our mortal fibre than as though the bugle blew us out of bed and the sergeant, backed by the whole force of the United States government, ordered us to work. It is self-discipline, self-control, as contrasted with external discipline, external control. The modern world requires always more

and more of this kind of discipline. That is one reason for the unexpected hardness and valor of all European and American troops in the late war—forty years of the discipline of peace.

The Germans showed the way to the perfect "psychological preparation." Its main object, though not its sole one, is perfectly to overcome the natural fear of death. The Italian peasants of the ancient Roman army, it is said, fought so valiantly partly because the men feared their officers more than they did the enemy. We have found another and more scientific way—the power of habit. Take a man and accustom him to obedience, instant and unquestioned, in every act of his life. To obey becomes in time a fixed habit, almost an obsession. The moment arrives when he must obey the whistle or the officer's command, and advance to probable death. Personal pride, fear of the disgraceful consequences in refusal, love of country, even sense of adventure, urge him forward of course; just as the natural shrinking from pain and death hold him back. But the governing factor in the perfect soldier is the ingrained habit of instant, unquestioning obedience. He goes because his very nervous reflexes tell him that he must.

I cannot find that in the old days of chivalrous warfare conscious hate played much part in the training of a soldier. The ideal—imperfectly felt and realized, but still an ideal—was the generous, adventurous warrior who hated his enemy perhaps,

but who spared him, too. "Brave as a lion, gentle as a woman." The Germans showed that there was a more useful method. "The best soldier is a bit of a brute," they said. In our military schools, we have always forbidden hazing. The German military schools encouraged it, in forms more gross than any of our youth imagined. That was done to cultivate the required touch of brutality. In the close race for victory of the last war, we all had to follow. Uninstructed civilians, visiting the American, French and British training-camps, wondered at the time given to bayonet practice. They knew that the bayonet was rarely used in action. Why so much stress upon it? Any sergeant could explain that. It was a means of cultivating hate, of making your soldier a bit of a brute. That dummy at which you were thrusting—the instructor encouraged you to imagine him a German, to curse him, to work up a savage delight in mutilating him. It was a part of the higher psychology of modern war.

There was propaganda, too—and here I must condense a theme for a whole book. This was one of the human forces existing before the great war, which the war reduced to its scientific terms; made tremendously usable. It was, really, our contribution. The American science of advertising had shown by what means an idea may best be implanted in the greatest number of people. With all the press under control, the European Boards of Morale and Bureaus of Propaganda proceeded with conscious

purpose to put into every people a mob-instinct of hatred for the enemy, man, woman and child. Since everyone who has a pair of working hands is useful to the purposes of a modern war, the hate-propaganda was aimed at the civilians as well as the soldiers. But "keeping up morale" in the army was the main object. Generating hate in the civilian population made toward that end. If the soldier on leave heard from his women, his father and his uncles that the enemy were all a set of ruffians, a race which had nothing in common with the human race, it made him a better hater when he returned to the line. Half-truth was the best tool of this propaganda; but, war being the negation of all ordinary morality, the propagandists did not gag at lies. For a familiar example, there is the story about the Germans cutting off children's hands in Belgium. It was not true. I repeat that I was in Belgium during the first month of the war; that there were German atrocities, some of which I witnessed—atrocities committed by order, for the strategic purposes of the General Staff—but that no case of the kind I mention was ever fully proved. Nevertheless it was a popular war-rumor in the beginning; it had all the qualities which make a story "go." It was taken up by the propagandists, spread as a means of lashing up hate by men who knew better; so firmly fixed in the public mind that I myself have but lately been called "pro-German" for denying it. In fairness, I may add that they lied more grossly in Germany,

especially when the case grew desperate. There, cutting off women's breasts was the favorite nightmare tale.

This hate-propaganda failed a little of its main purposes. The soldier swallowed it less avidly than the civilian population. If you wanted a tolerant view of the enemy, you were most likely to get it from a soldier sitting in a dugout under fire, his gas-mask at the alert. If you wanted to hear that the enemy was a creature not quite human, but a species of gorilla which should be exterminated to the last baby, you must go to some comfortable home in Paris or London—or equally I suppose in Berlin. Indeed, whole elements in the European armies quietly closed their minds to this form of propaganda. British officers of the old school, for example, tried to maintain the tradition of the warrior chivalrous even in his thoughts. It was a conventionality of most British headquarters messes not to speak ill of the enemy. If the civilian visitor introduced the "hate-stuff" into the conversation, he was answered by polite denials or by frigid silence.

All this must be changed in the next war. You must focus your hatred where it is most useful and needed—in the soldiers at the front. And we are studying to change it. The propagandists and boards of morale are working and experimenting like the chemists—coolly reviewing the methods and mistakes of the last war, finding new methods without mistakes.

Has the involuntary discipline of armies much to do with the voluntary discipline of peace? The aftermath of the late war goes to prove that the relation is a little remote. I know hundreds of young men—British, French, Belgian, Italian, American—whom the war seemed to have spoiled at least temporarily for civilian pursuits. Accustomed to be disciplined by others, they seemed to have lost the habit of disciplining themselves. They found it difficult, almost impossible, to make themselves go to work at regular hours, stick to any one job or any practical object very long at a time. This psychological aftermath of the war we all know, I think. You might lay it all to the actual war—its stresses and excitements, its alternate tense action and idleness—were it not that we find the same state of mind in young Americans who were mobilized in the draft, had their year and a half of army training, and never got abroad. It was hard to "settle down"; which means that it was hard to change from imposed discipline to self-discipline, from the regularity of army life to the fast, irregular competition of civilian life.

The world over, we found that the hate-propaganda, the conscious effort to make the soldier "a bit of a brute" had long effects. Everywhere were "crime waves"—highway robbery, burglary, sudden murders of passion. Ours was perhaps the lightest of all. The police records of Berlin in 1919 read like annals of the old days of Jack Sheppard. The

Belgian police were forced, for the first time since Barons ruled in Flanders, to fight organized gangs of bandits. England boasted in old years a low murder rate; and her courts had a swift and certain way of hanging for murder without regard to wealth or social rank. "The unwritten law" did not exist for British juries. Just after the war, England experienced a series of "murders of passion," by ex-soldiers and ex-officers; and British juries acquitted the murderers as lightly as once did Latin judges. How much of this mentality back of these crime-waves sprang from actual experience at the Front and how much from the education in brutality of the new military training, no one of course can say. Doubtless both influences bore on this crime wave.

Here in America and abroad, there are plans afoot for knitting army training a little more closely into civilian life. Experts on physical culture have testified that drill and setting-up exercises, as hitherto practiced by armies, give an imperfect and one-sided physical development. It is proposed to revise army physical training on modern lines. It is proposed, further, to teach the men, while they are in the ranks, the elements at least of useful civilian trades. These are compromises, at best designed to reduce the ultimate cost of armies to society, at worst sops to public opinion. The chief end of military training is to teach men to fight. They must be drilled, first in order to inculcate the instinct of perfect obedience and second so that large bodies

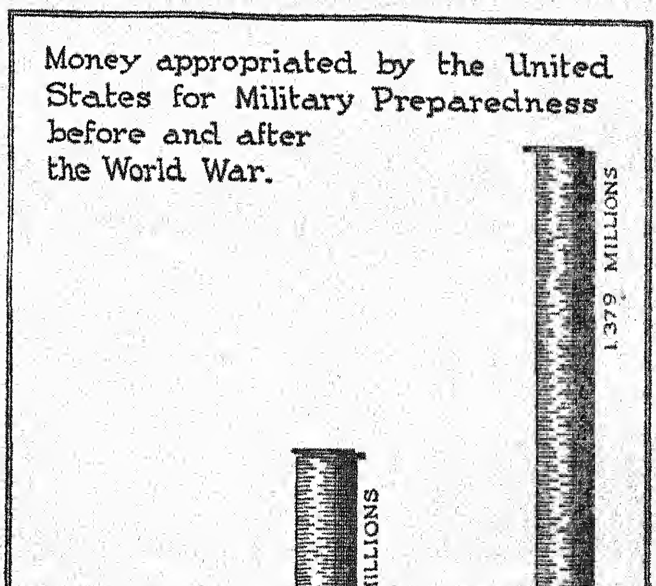
of troops may be moved without confusion. They must learn to use weapons, from the trench-grenade and the rifle to the aeroplane and the tank. Most of this training, from the point of view of ordinary, peace-time industry, is wasted. One of the chief economic losses in military training is the time and energy it takes from the most teachable years of best young men. It will be "war by machinery" in future; and those told off for the higher functions of war—such as tanks, aeroplanes and gas—will get, it is true, a certain training in mechanics and chemistry. But in just as much as these devices differ from the devices of peace, in just so much will the training be wasted, socially and economically.

CHAPTER XI

"DEFENSIVE PREPARATION"

WHAT should be our American attitude toward military preparation? The average hard-headed, practical American will perhaps say that if war has grown so deadly, it is all the more reason why we should prepare to defend ourselves. Without defence, we stand in peril of general extinction; with defence, we may avert war at least for a time, may soften the blow when it comes. Let us prepare then, says the American citizen, not for conquest, or "fulfilment of national aspirations" but for defence.

Yes, provided only that we can, in this age of confusions and complexities, keep our military preparations defensive. And that is extremely difficult. Indeed, when you come to thorough defensive preparation, a hundred per cent efficient, it becomes perhaps impossible. The term "defence" needs defining; it has hitherto been used as a most effective hypocrisy of militarism. Keeping our coasts and borders against an invading enemy is pure defence; no one disputes that. But in the modern world a nation is not confined to its own political borders. The American mining engineer developing a lode


Money appropriated by the United States for Military Preparedness before and after the World War.
279 MILLIONS
828 MILLIONS
1379 MILLIONS
1909-1910
1920-1921
ESTIMATES 1921 - 1922

for the Ameer of Afghanistan is a part of America, just like the mining engineer driving a tunnel in Colorado. At this moment, that larger America is spreading. There is a new movement in world-industry. Instead of bringing the raw material to the power, men are beginning to bring the power to the raw material. India raises much first-rate cotton; she has also inexhaustible resources of labor. Hitherto, she has sold the raw cotton to England, where the coal is; now, India is going to spin and weave part of this cotton beside her own fields, partly with native water-power, partly with imported coal. We have the money of the world; and American capital has been flowing by hundreds of millions into such projects as this. If we are to have the perfect defence, we must prepare to back up American citizens and "American interests" in India as well as in Indiana, in New Guinea as well as in New York. It is hard, it is almost impossible, to draw the line; so we are pulled insensibly into the old, vicious circle.

There comes a point in any thorough military preparation when the spirit of defence runs subtly into the spirit of offence. Again, Germany is the typical case. She was, her emperors, kings and generals said, "ringed with foes." That, in the beginning, was not an entirely insincere presentation of the case. On one side lay France, smarting with the injustice of 1870; on another lay the barbaric Russia of the Czars, with double Germany's man-

power and an eye on Germany's developed wealth. On her seacoast lay the strong British Navy. "What is Germany?" asked question 1 in the public school catechism on geography, "It is your Fatherland, entirely surrounded by enemies." Militarism was hammered into the German people in the form of defence, defence, always defence. And let me repeat; in the beginning the men who urged this were not all insincere.

Germany went into the game of financial imperialism with the rest. The world was spotted with "spheres of influence," where German capital harvested fields of trade or raw materials for the factories of Berlin, Leipsic, Düsseldorf. These interests must be protected; other capital must be kept out. The German army began to pass from a defensive force to an implied offensive force. In such crises as the transfer of Bosnia and Herzegovina, the Germans won because the Kaiser rattled his sword and the others yielded for fear he might turn loose his perfect army.

There came, too, a mental change. "He who forges the sword will want to wield it." Here is one of the ways in which a national mind works like an individual mind. You have found, we will say, that you play an extraordinary game of lawn tennis. You will not long be satisfied with scrub games. You will want, if you are a normal man, to enter tournaments, to prove your accomplishment and superiority before the world. You discover that you

write good poetry or fiction. How long will you be contented with sugared sonnets among your private friends? Sooner or later you will want to publish it and let the world see how clever you are. And so when you have the perfect army or navy, perfectly knit into the structure of the state, you will find some impulse which you may not at the time analyze, urging you toward its proof in action.

Germany did. There was never such a glittering display of military power as in the old summer manœuvres before the war. Doubtless any German who saw that great charge of massed cavalry by which they always ended, felt somewhere in him a glow as he thought of what Germany might do in real battle. The cloud gathered. With Germany—as even most Germans now admit—lay the decision for peace or war; and she chose war. It is absurd to blame the Kaiser alone; almost equally absurd to blame his counsellors alone. They were carried along, all of them, by a flood which had been rolling up in Germany for forty years.

Yet even then, they maintained the fiction to their people—and half to themselves—that they were fighting a defensive war against the "ring of foes." The average German soldier whom I saw in Belgium during 1914 believed this devoutly. Barbarous Russia and envious England had attacked the Fatherland. He fought in her defence. France must be crushed because she had foolishly joined these major enemies. Poor France! Now, if they

survive, these same Germans are calling France the source of all their woes, the true enemy. For the current is running in another direction, and the strategy of propaganda has changed. But this is a digression. Germany illustrates, among other things, the danger in the perfect defensive preparation and the difficulty of drawing the line between defence and offence.

Some may note that I have not touched upon the question of national honor. The individual in society sometimes meets a situation outside the law so intolerable that he is less than a man if he does not take the law into his own hands; and so it is with nations. The circumstance which drew us into the Great War was an unusually clean-cut example of an unpardonable affront. Germany had announced cold-bloodedly, flatly, that American vessels could no longer sail the most frequented seas of the world; if they did, the hulls would be destroyed, the crews killed without warning. The occasions of war are not commonly so simple as this. "National honor" is more often the excuse for economic and political interests, or the mere focus of trouble arising from a conflict of such interests. The occasion of the Great War, the spark which set the mine, was the assassination of an Austrian prince in Serbia. Behind that lay thirty or forty years of intrigue leading up to a "situation." Austria wanted to make Serbia a vassal economically, and in the end politi-

cally. Germany wanted to extend a "line of influence" through the Balkans in order to build an all-German Berlin-to-Bagdad railway. The Entente nations wanted to prevent all this. Had no such situation lain behind the assassination at Sarajevo, the matter would have been settled with an apology, punishment of the criminals and perhaps indemnity.

Let us imagine another case. Mr. Colby, then our Secretary of State, visited South America in 1920. Suppose that in Rio de Janeiro some fanatic or band of fanatics had murdered him. Would that have led to war between the United States and Brazil? Almost certainly no. But suppose that Brazil and the United States had long been engaged in an economic and political struggle to control by their capital the resources of Ecuador, Colombia and Central America. Suppose them both prepared to the last belt-buckle. Would it then have led to war? Almost certainly yes. And most Americans would say—as did the Austrians in 1914—that we were drawing the sword to avenge national honor and wipe out an intolerable insult.

Building up armies, navies, and munitions industries solely through the fear of national insult, solely to protect honor, seems a little like carrying a loaded pistol night and day lest perhaps someone insult you intolerably, beyond recourse of law.

Yet the fact remains: few Americans of spirit will want, in this era of the world, to strip us of all our defences. That goes beyond the reasonable pacifism

which has hitherto been the general American attitude toward war. It becomes the non-resistance of the dreamer, Tolstoi. Apart from its danger, completely laying down our own arms would be no good, except by example. We must reach further back than that into the structure of things; try, with all the others, to repair this world-machine. At present, it is like some great, complex engine which has broken a vital part. It tends to beat itself to pieces with its own power.

CHAPTER XII

THE DRAMATIC MOMENT

Now is the appointed time to begin action, and we are the appointed people. The lesson of the last war is still fresh in mind; and unto us, by luck rather than our own foresight, has been given the dominating position in the world of the next quarter-century. The course which the United States chooses will largely be the course of the other nations.

It is the appointed time for still another reason, less obvious, no less compelling. All old, imperfect human institutions have their uses in their period; then that usefulness passes and we must rid ourselves of them. Monarchy in its absolute form served the development of humanity. The half-civilized man could not grasp conceptions so abstract as his relation and his duty toward other men in his group or clan or nation. He needed a visible, personal representation of power. So was built up loyalty; from loyalty grew the fine sentiment of patriotism; from patriotism the sense of team-work in society. Then monarchy was outworn. We sloughed it off, at first in its absolute form, then faster and faster in any form at all. Slavery may

have been necessary to build up the habit of steady work among tribes and nations. Races learned the habit of steady work, and sloughed off slavery.

War on the whole was long useful to humanity—expensive, but the best way we had. I have previously quoted Wells to show how it drew races into the circle of progress. Long before there was history even in popular ballad, some genius in some tribe of the Asiatic steppes invented the wheel. His tribe went to war and won or lost—that does not matter. Before the war was over, the enemy had seen the wheel, learned its usefulness, was making wheels of his own. But for war, outlying tribes on the fringe of humanity might have skidded their heavy burdens along the ground for centuries and æons. At the end of the Stone Age, some savage discovered that tin and copper, thrown into the fire, melted, blended, produced a substance which could be hammered to a fine, sharp edge—a tool much better than any chipped stone. He used his bronze knife in war; the enemy felt its edge, admired, penetrated the secret, passed it on by war to tribes still further outlying. So we progressed from the Stone Age to the age of metals.

War, too, worked with monarchism to develop what scholars call the group-consciousness. It stirred up in men a fine, high, human emotion for the humanity outside themselves. The average man in all times and all nations up to the eighteenth and

nineteenth centuries led an extremely limited life. Of his own motion, he seldom stirred from his own domain or farm or village. War alone drew him out to teach him that there was a world beyond his horizon, that there were other men with other ideas not only among his own people but among stranger clans. War made a tremendous contribution to human experience, to collective human consciousness. That was its use, its larger reason for being.

Now, modern invention has changed all that. We no longer need a process so essentially wasteful to transmit the results of progress. When Wright proved to Europe that a man can fly through the air, the news was flashed that very night to every corner of the globe; three-quarters of the civilized world read it next morning. Within a month, such remote points as Shanghai, Cape Town and Buenos Aires had European publications with technical reports; any good mechanic who wished could go about building an aeroplane. The remote parts of the globe were by now coming fast into the circle of communication. Before the Great War, all the inaccessible places had been explored—even Thibet and the two poles. The world had no more secrets and mysteries. From end to end of Africa, the infant continent, ran a railroad; Africa was spotted with European settlements, in touch with civilization by telegraph-lines. The printing-press, the railroad, the automobile, the electric telegraph have all given

their part toward the intensity of modern war; yet at the same time they have removed one of its supreme necessities for being. As for its other use—instilling into men the sense of a duty toward his country or his group—that work also is done. In fact, when one considers the conceited, excessive, Jingo patriotism of most races and nations, it becomes a question whether it is not too well done.

We cannot say at what precise moment in history monarchism and slavery proved themselves outworn, past their usefulness; became not benevolent organs but dangerous rudiments—like a vermiform appendix—in the body politic. But war, always picturesque, died its spiritual death dramatically. We may say with certainty I think that it proved itself outworn during that little moment of history between 1914-18. It was of no more use in spreading progress, of little more use in building up the sense of collective duty. And in itself it suddenly became dangerous, sordid, disturbing beyond the imagination of devils.

Two great tasks lie before humanity in the rest of the twentieth century. One is to put under control of true morals and of democracy the great power of human production which came in the nineteenth century. The other is to check, to limit and finally to eliminate the institution of war. This last is the more important. We may stagger on, and make progress even, though the industrial and financial structure remains as it is—we were

doing very well, on the whole, before 1914. But if war goes on unchecked, following its present tendencies, it means the elimination of whole races—always the best races—and the downfall of civilization.

CHAPTER XIII

PROPOSED WAYS TO PEACE

PERHAPS we cannot eliminate war. It seems so deeply rooted in human institutions! It is so easy to stir up hate, so hard to create understandings! Thus, in the late eighteenth century, the republican must have felt about the elimination of kings. The institution of monarchy appeared unassailable—the task seemed at times hopeless. And surely we cannot, unless we work up the zeal of those early republicans, make reasonable pacifism a governing motive in our political thinking and action.

Yet this reasonable pacifism had made progress, even before the late war. Peace, all the reference books will tell you, had in the nineteenth century cast off its old negative meaning and taken on a positive meaning. It was no longer regarded simply as the rest between wars; it was an end in itself. The Hague Conferences, powerless as they were to prevent either the great war or its barbarities, still showed that a great part of humanity wanted peace, would take much trouble to get it. We, by our relations with Latin America, proved how two continents might live in practical harmony. When Secre-

tary of State Blaine called the first conference with Latin America, he set up a milestone on the road to permanent peace.

So strong indeed had become this desire and hope among most Western European nations that the very militarists among the Allies were forced during the late war to use the phrase "the war against war" in order to keep up the fighting spirit among their people. And when the war was over, the attempt to form a League of Nations afforded still another proof. I shall not enter into the late controversy. But the League was the work of politicians, all responsible to democracies for their jobs. They would never have made the attempt had they not believed that it would be popular.

The Peace of Versailles, imperfect though it may have been, proved in other ways how far we had moved beyond old conceptions of national glory. After former wars, the conquerors usually took over without shame the territory of the conquered, no matter how the inhabitants felt. Even as late as 1871, the neutrals did not protest officially and but very little unofficially when Germany seized the unwilling Alsace-Lorraine. But in the Peace of Versailles, European statesmen had to give at least lip-service to the principle that no nation or no part of a nation may permanently be held by a conqueror against the will of the inhabitants. Again: they did this because they were politicians, and had satisfied themselves that a new moral consciousness in man-

kind demanded a new conception of national rights and methods.

Back from the war came the plain men of the democracies old and new—thirty or forty millions of them. The greater part of them, and especially the thinking part, had been quarreling in their thoughts with the institution of war. If our returned soldiers felt this less than their European comrades, it was because they had borne a shorter strain and had needed less of the propaganda of peace through war to keep up their morale. The *Société des Anciens Combatants* in France corresponds to our American Legion. Lodge after lodge of that society in 1919 passed a resolution saying that their real object now is *"la guerre à la guerre"* (war against war). The rumor, spread by governments as a feeler, that the British and French armies were going to Russia to fight the Bolsheviki produced instant riots and mutinies. I witnessed the Ruhr Rebellion of April, 1920, in Germany. Now while this revolt was stirred up by the Communists, the average Ruhr insurgent, I found, was out primarily to end militarism. "If those soldiers have their own way," said the men of the Ruhr, "we'll be fighting the French again in two years. We don't want any more wars."

Yet so strange are these times that governments, supposed to be the expression of peoples, emerged from the Peace of Versailles more nationalistic, perhaps more belligerent, than ever before. Na-

tionalism, the denial of peace, is running riot. Those returned soldiers, with all their pacifist sentiment, find themselves like the rest of humanity caught in a wheel. Jean the Frenchman does not want any more war. But the North lies devastated; until the fields of the Somme are bearing again, the chimneys of Picardy smoking, his shop will never do good business. Hans the miner of the Ruhr district got out his army Mauser last year and tried to shoot a reactionary officer in order to show that he wanted no more war. But Hans believes that the indemnity which France wants is excessive; he knows that if Germany pays it, he himself will have lower wages and higher taxes all his life. So Jean and Hans put their interests into the hands of the strong men of Europe—men with the old ideas, men whose conception of statesmanship is force unlimited. "His only scheme of politics," said an American diplomat of an eminent European confrère, "is 'send a division.'"

The pacifism of the returned European soldier, of the disgusted but submerged European civilian, is a somewhat abnormal state of mind. It resembles a little the psychology of a religious revival. Not even the most enthusiastic revivalist expects that his people will maintain permanently all those heights of fervor and virtue to which he has raised them. The wise church is the one which consolidates its gains; makes the revival or mission yield permanent fruit in sober, day-by-day piety, unselfish-

ness and good living. If we let this moment pass, the nations will forget. The memories of the horrors, the destructions, the follies of Armageddon will die out as its debts are paid off, as the new generation grows up; and, as in old wars, only the souvenirs of its glories will remain.

Now, I repeat, is the appointed time to consolidate what Armageddon won for peace, and we, both actually and potentially the strongest nation of the world, are the appointed people.

Along what practical lines may we proceed?

Doubtless accumulated experience, translated into policies and action by men of genius, and leadership will find us new ways. But here are the courses of possible action on which many are thinking at present and a few working:

First and most drastically, we may create a real law, not a mere set of gentlemen's agreements between nation and nation. That is the kernel of the matter.

Law is the set of agreements, backed up by some kind of force, to prevent murder and theft and injustice between the individuals of a tribe or a state. In the savage beginning of things, men probably killed whomsoever they wished, took whatsoever they desired. But people could not get along and make progress on that plan. An individual with the fighting endowments of a Jack Dempsey had it all his own way. Before long, men got together and drew up primary rules of the human game. You

kept, we will say, the stone knife which you had chipped for yourself. No one might take it from you except he give an equivalent; no one might kill you except with certain definite excuses. It was further agreed that whoever broke this rule should be punished by the collective action of all the rest. No one man could thrash the Jack Dempsey of the tribe; but two or three men could, much more the whole tribe. That was the beginning of law and order—an understanding as to the rules of the game, an agreement to punish whoever broke those rules. Wise old David Lubin used to say that he believed this was also the beginning of morals. And indeed, even if there was in primitive man some inbred sense of kindness and of property right, that feeling never expressed itself in action until men drew up rules and agreed to back them by force.

Nearly everyone who thinks must have wondered at times why it is supremely wrong to kill a fellow citizen in time of peace, supremely right to kill a foreigner in time of war; why lying and deceit, despicable when used against your fellow-countryman, become noble when used against your national enemy. I have explained the reason. As soon as we organized states and tribes, we began to endow them with a personality, to give them a being. And between these beings the law did not run. They had never got together, to draw up rules of the game and provide penalties against the violators of this code of morals. Consequently, there were real-

ly no morals between states. If in times of peace nations refrained from murdering the citizens of other nations, from seizing their property, that was because they feared the disagreeable consequences involved in these acts. It was, again, like the state of primitive society before men made laws and organized a police force. When one primitive man respected his neighbor's property, it was because he did not care to get into a fight. The process was too disagreeable; it was not worth while. But when his desire grew greater than his fears or when his blood was heated, he took or killed with at best only a vague sense of moral wrong.

But finally, when the law within nations became so perfectly established that murder, theft and arson grew uncommon, sporadic, it was as though the reservoir of morals filled up and began to flow over the dams dividing nations. Diplomats and others who represented sovereign states went on lying, deceiving, committing daily in peace or war acts which, performed by one citizen of a state against another, would have been punished by ostracism, jail or the gallows. And they justified themselves to themselves and their fellow-citizens because it was done for the flag, the Patrie, the Fatherland. The cause sweetened any method. But public opinion concerning some of these methods grew so strong as to force these gentlemen at least to hypocrisy. Since the state knows no morals in its relation with other states, a treaty used to be a sort of temporary agree-

ment for temporary advantage. You kept it because it did not suit your convenience to break it. If a treaty became no longer convenient to one party or the other—well, kings used to tear up treaties and feel very little necessity for apology or explanation. When Germany violated one of her most solemn treaties and invaded Belgium, she broke, really, no moral law. Do not believe that the cynical diplomats of the Entente Allies blamed her in their hearts. But peoples did blame her. The moral sense of individuals the world over rose against such an act; a man who behaved in this way counted himself out of society; why not a nation, too? The one fact which German propaganda could never explain away was the invasion of Belgium; it is perhaps the spiritual reason why Germany lost the war.

So we have already the moral basis for law between nations; at present, however, it is a force, not a power, because it has no machinery to make it useful. It is like the potential electricity going to waste in a mountain river. This force will not become power, will not turn wheels, run railroads and light cities, until you harness it—create for it some machinery.

We shall not strike at the root of wars until we organize fifty or sixty sovereign nations and self-governing colonies of the world somewhat as we organize individuals in a tribe or state or nation. In plain, human terms, they must get together, pass

laws to define and forbid national murder and national burglary, and agree to punish, with their collective force, any violator of that law.

The punishment need not wholly, need not mainly, consist in physical force. The discussions preceding the League of Nations showed, theoretically at least, that a general economic boycott might be as effective as military action. This follows a rule of progress in human society. Once, law knew only one kind of penalty for crime—physical action. The criminal was killed or mutilated or flogged. In the eighteenth century, the English would hang a man for stealing six shillings. We have done away with flogging and mutilation, have abolished hanging except for the gravest crimes. We have substituted imprisonment and fine. Think it out and you will see that imprisonment is mostly an economic penalty, as a fine is wholly an economic penalty.

This book, I repeat, is not a plea for or against the existing League of Nations. Call your organization a League of Nations, an association of nations, a Hague Tribunal "with teeth in it"—call it what you will, organize it how you will. This is the specific for the disease of war. But while we wait for this inevitable organization to form and to become effective, we may use a few pain-killers and poultices.

Among these, the most important is disarmament—a pressing, vital question of the moment. Behind the present agitation lies a compelling economic

motive. Europe cannot recover if she goes on with the old race for armaments. She will collapse under the double burden. The world is so interlocked that if Europe blows up in anarchy we, though we hold together, must suffer terribly. An agreement to limit armies and navies to the point where they cannot be used aggressively can probably be enforced. We have no formal law between nations, it is true; but that uncharted moral opinion of democracies is perhaps powerful enough to secure a rough working agreement until we get something better. It cannot be done without the consent—indeed without the leadership—of the United States. We have as much economic and industrial power to manufacture navies and munitions as any three European nations, more population to furnish soldiers than any two Western European nations. If we arm to the teeth, the rest must follow through fear.

Such partial disarmament will serve not only as temporary alleviation; it will be also in the nature of a remedy. Whatever movement sets the nations thinking positively about peace, whatever forces them into co-operation instead of competition, makes toward their final, complete understanding. Finally, it will prevent the psychological drift toward war which comes with perfected armaments.

If I have anywhere made it appear that the term "militarist" is equivalent to the term "professional soldier," I have done the military clan a wrong.

Only lately our two most eminent soldiers, Bliss and Pershing, have come out flatly for a disarmament program. They admit that it will not be easy; and no more will it. You cannot complete the job with a Congressional resolution and a flourish of the pen. Too many eminent gentlemen in all nations have something to gain by the race of armaments. But it is a first necessary step.

Then, even before we have a league, association or effective High Court of Nations, we may get at some of the economic causes for war.

The "financial imperialism" which brought on the Great War had three wholly commercial objects—trade, raw materials, export of capital. The struggle for trade—for profitable foreign markets—is, in the opinion of many economists, the least dangerous of the three. For while it is a cause of friction, it has also a pacific tendency. When two nations begin to trade with each other, there follow personal acquaintance and a community of interest. We saw that at the beginning of the Great War, when many Americans in the exporting business sincerely took sides either with Germany or England because they had with Germans or Englishman business relations and personal acquaintance. The most dangerous factor in national trade is tariffs. I am not preaching for or against tariffs. But they can be so drawn as to take unfair advantage, to work injustice against some given nation. The tariff is no longer purely a domestic question. We must draw

our schedules no longer with an eye solely on immediate national prosperity; we must consider them also in the light of good and just international relations.

Some kind of international agreement concerning the distribution of raw materials seems necessary to permanent peace. If any great nation should in this year corner the international supply of flax, for example, the great linen industry of Belgium would be ruined; for Belgium raises only a little domestic flax. Italy has most expert and intelligent workmen, together with certain other manufacturing advantages; she has no coal nor iron ore. Shut off coal and iron from Italy and the Valley of the Po knows acute distress. No longer should any nation or combinations of nations be allowed to monopolize any imported raw material.

Finally: the advantageous export of capital was perhaps the main object of financial imperialism and so one of the main causes for the late war. In the intense struggle at home, your capital would yield you only three or four or five per cent. Put into a new, undeveloped country, it might yield you—anything. Only it would not return its big interest-rate for long if other capitalists in other nations themselves saw the chance, came in, and competed. The game of the international flotation houses which represented national surplus capital was to keep their "sphere of influence" exclusive. This was the chief commercial object of the huge arma-

ments, the rattling of swords when diplomacy ran into a deadlock. Before the Great War that process was running a dangerous course in China. Here, you were in a British "sphere of influence"; in general non-British capital was not wanted, could not get a foothold. Here, the influence was German; here, French. And the nations were jockeying to extend their sphere further and further into China—without regard of course for the feelings of the inhabitants.

Some internationalization of export capital seems necessary to permanent peace. This may come through an association of nations; it may come before that association is effective through action of the great flotation houses. Most banking men want peace; war is too disturbing, armaments are too costly. But in strategic control of the world's financial interests before the war were too many ruthless adventurers allied with the military and financial adventurers. Banking also was caught in a wheel. There are the signs that sober sense is coming into this business. The "Chinese consortium" is an association of the capital of many nations for investment in China. It may be open to criticism on some grounds; but let us give credit where credit is earned. Such an arrangement tends to do away with "spheres of influence," with the seeming necessity for keeping up armament and a state of passive warfare in order to protect export

capital. It squares with the international finance of the future.

Last but not least, we Americans have it in our power to abolish that secret diplomacy which, everyone agrees, makes toward wars. We cannot have much secret diplomacy ourselves, since all our international agreements must be thrashed out and ratified in the Senate, and so published. The trend of the period, fortunately, is against the gum-shoe method of arriving at national understandings which become in due time misunderstandings. Really, monarchs before the great war had not nearly so much irresponsible power as diplomats; and the right to conceal their agreements from their people was their best tool. That is changing. Great Britain, once as much a sinner as the rest, has but lately registered and published with the League of Nations the twenty-one treaties and agreements which she has made since the war, has given her national word of honor that she is holding nothing back. Even before we enter some kind of association of nations, we have probably the power to end much of the secret diplomacy. We need merely announce that we will not recognize any treaty which has not been published to the world.

Yet—returning to the kernel of the matter—we, the citizens of the world, shall not find that the organization of law between nations is enough in itself

to keep peace; just as within the nations of the world law alone is not enough to prevent crime and establish order. You may happen to see this morning a beautiful automobile which you would like to own, standing unlocked and unguarded. Why don't you jump in and drive away? First, because you fear disagreeable consequences from the law. The police will chase you, probably catch you, eventually put you in jail. But is that the only reason? No; you are restrained by an instinct first implanted in your little, savage bosom at your mother's knee, and intensified by your whole education—the feeling that it is wrong to steal. In order to keep society together, we need both these forces.

So it goes with this question of order and morality among nations. We need the law; we need also personal ethics—international morality. By the forces of light which we have—churches, schools, all associations of men for spiritual and intellectual ends—we need to strengthen the belief that a state, including your own, *can* do wrong, that between nations there is such a thing as live and let live, that humanity is greater than mere race.

This does not mean abolishing the sentiment of patriotism. There are two conceptions of that noble old emotion. One ends at the mental condition of Germany in 1914—the state for the state's sake, your hand ever on your sword to protect her honor and her interests, though every person in the state be rendered less happy by the process. The

other regards the nation as an agency for the greatest good of the greatest number. He who follows this conception takes his pride not in his nation's hollow victories of arms but in her achievements of order, common prosperity, art, science, industry. The one is the old-fashioned patriotism, grown in the twentieth century to a world-menace; the other is the patriotism of the future.

Again let me make a human comparison. In all times poets have sung of the nation as the Mother, of its citizens as her sons and daughters. Now you may interpret your love for your mother in two ways, one sane, the other a little insane. You may work peacefully to keep her happy and well-housed and well-fed. This, I suppose, states the attitude of most of us toward our mothers. But of course you may go round with a pistol in your pocket, always ready to start a fight with anyone who may say that she is not the best of mothers, or watching for an opportunity to hold up a shop and steal the fur coat which she happens to want. So, I suppose, the savage expressed his love for his mother in the days before the law; in recent ages we have had less and less patience with this form of filial devotion.

CHAPTER XIV

THE TEMPTER

Now, my America, I will take you to an exceeding high mountain; I will show you all the kingdoms of the world and the glory of them.

What an opportunity we have in this year 1921! Here we sit in the midst of our Continent, great and rich as all Western Europe. Almost are we unscathed by the war, while the others which were Powers but six years ago struggle now with anarchy and bankruptcy. The power of Powers has been given into our hands.

The British navy once held mastership of the seas. We can now take mastership ourselves. Ships are made of steel; the great steel-producing nation may if it wishes be the great naval nation. And steel is made of coal and iron. While the British coal measures ever shrink, we have only begun to tap ours; while the British struggle for imported iron ore, we mine more than we need. And so clever are we at mass-production that we make more steel to the man and to the furnace than any other people of the world. Great Britain kept her navy stronger than that of any two other powers; we,

with less effort, may keep ours stronger than that of all the other powers.

Think, too, of our military potentiality! We may, if we will, summon to the colors more soldiers than France, Germany and Belgium put together. And what soldiers! Beside our stalwart divisions, their comrades on the European battlefields looked scrawny. We have learned war, now; the American army has been brought up to date. We have at this instant more munitions, lying greased and ready in storage, than any other nation on earth. We have more manufacturing power for new munitions than any other two nations. Back of it all, we have the American ingenuity which gave the world so many of its industrial inventions in the nineteenth century. We, of all, will know best how to keep ahead of the new warfare. Did we not invent Lewisite gas? Did we not show how aeroplane engines, hitherto manufactured painfully by hand, could be poured out by machine processes, like Ford cars?

South from our borders to the isthmus runs a succession of undeveloped countries, as rich and nearly as large as our own national domain. They need capital; we are exporting capital faster and faster. Here lies much profit for us all—if we can keep the field exclusive. Our diplomacy, if backed by the unprecedented military power we have at command, can keep it exclusive. Then, some day when we hold a tight financial grip on Mexico, Guatemala

and the rest, there may follow—incidents. We may find it necessary to go down and take these countries over—as a means of defending Americans and American capital abroad. Why not? Is not our civilization better than that of Mexico and Guatemala? Will not the inhabitants be higher and better if we take over their responsibilities and make them Americans?

Canada lies to our North; very rich in resources, less developed than we are; inhabited by people with the same language as ours, of very much the same habits of thought. When we have the dominant navy, perhaps the British Empire may break up; perhaps Canada may wish to throw in her lot with us, either as a member of our Confederation or as a close ally. West of us lies the Pacific; with our dominant fleet, we may make it an American lake.

What national greatness, what glory! "Dominion over palm and pine"—why, we shall hold dominion over Arctic tundra and tropical jungle. No empire, whether it be Rome of the second century or Spain of the sixteenth or Great Britain of the nineteenth, ever held complete, undisputed mastery of its own continent. But we shall. The old Spain of the Philips called the Mediterranean "Mare Nostrum"—our sea—the little Mediterranean! Our sea will be the Pacific, mightiest of all oceans. With what a thrill may the schoolboy of 1950 sa-

lute our flag, symbol of such power and glory as never was since history began!

So was Germany led to an exceeding high mountain. Germany listened to the tempter and chose the kingdoms of the world. And Germany in 1921 . . .

Ah, but the tempter never lets you read to the end of the chapter; never shows you the whole picture. Behind these gorgeous visions floating in rosy mist lurk death . . . poverty . . . starvation . . . despair . . . a civilization become offal and ashes. He does not show you these; he knows that he is at war with the purposes of eternity.

THE END

GENERAL AND REGIONAL GEOGRAPHY FOR STUDENTS

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PREFACE

THIS book is an attempt to survey broadly the whole field of Geography, and includes therefore the subject-matter of what is frequently termed Physiography as well as that of Political and Economic Geography, for only by the combination of these aspects of the subject can the study be either scientific or educational.

The treatment is as far as possible causal, and no facts are given without explanation. This necessitates the devotion of nearly half the text to World Geography, since by regarding the World as a Globe many fundamental phenomena, as for example the changes of the seasons and the great wind systems, may best be understood. Further, the relationships between the various phenomena, especially the Sun's rays, the winds, rainfall, vegetation, and human occupations, are most clearly seen by considering their distribution over the Globe.

While for the younger pupils it is best to introduce the idea of causal relations by a study of particular facts as observed in the home region, and to follow this by discovering the same relations elsewhere, yet for older students who have once obtained such ideas, general principles may be formulated and their consequences deduced, and the modifications of these, due to varying local conditions, may be noted and examined.

After a consideration of the separate physical factors, these are viewed in combination with one another, and the World is divided into Natural Regions, somewhat in the way suggested by Professor Herbertson.[1] A statement of the characteristics of each region affords a convenient summary of the physical, and a rational basis of the economic, geography. Having studied the natural regions, either of the World as a whole or of each continent, the student readily remembers the salient facts of the geography of any area, and possesses a framework into which he can fit particular facts, such as place-names or lists of products, and details drawn from other sources.

[1] In the paper on "The Major Natural Regions," published in *The Geographical Journal*, March, 1905. In this paper also appears the method of indicating seasonal distribution of rainfall adopted in Figs. 81, 82 and 83 of this book.

The treatment of the various regions has been made as systematic as possible, but the marked differences between the continents prevent absolute uniformity.

Britain, as the home region, has been dealt with in greatest detail; the space allotted to Europe and the other continents has been determined largely by their relative political and economic importance, but the portions of the British Empire situated in each region have received special attention.

The book represents a deliberate departure from tradition in several respects where recent advance in geographical science warrants such a course. At the same time it is realized that change must be gradual, and the requirements of those working for important public examinations have been carefully considered. Moreover, explanations of physical phenomena have been given in such a form as to present as little difficulty as possible to students who have not received a definite scientific training.

The wide scope of the book has necessitated careful selection of material, and the rejection of the less important facts and those which have not a real geographical significance. For the same reason it has been impossible to include detailed descriptions; the value of these is recognized, and the sources from which they may be obtained are indicated in the short list of books appended to each section.

These lists also include the chief authorities upon which the text is based, and to these works it is hoped that this book may form an introduction.

PREFACE TO THE FOURTEENTH EDITION

Much of the economic and political geography of the World is in a state of flux after World War II. Hence some statements have been altered, but many others have had to remain though they may not give a complete or accurate picture of things as they are at present. It is, therefore, more than ever necessary to supplement and correct facts here stated by information from newspapers, journals and current reference books.

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PART II

REGIONAL GEOGRAPHY

Part I
WORLD GEOGRAPHY

[*Note to Students.*—As the subject-matter of this part of the book is arranged, as far as possible, in a chain of cause and effect, it is necessary to read the chapters in the given order (with the possible exception of Chapter XII) and to obtain a thorough grasp of each before proceeding to the next.

The maps are particularly important. They should be studied carefully in connexion with the text, and all suggested comparisons should actually be made. Maps showing the relief of the land should always be at hand to aid the understanding of these maps.

The facts they show should first be examined and, as far as possible, explained; they are not treated exhaustively in the text, hence they offer opportunity for further individual work. Secondly, the main facts should be visually memorized that they may be reproduced as required; to this end, the drawing of sketch-maps showing the chief features is a most useful exercise.

It must be remembered that in almost all cases boundary lines represent gradual transitions and not sudden changes, and that on these small-scale maps all details are omitted and the facts shown in a generalized form.]

CHAPTER I

MAPS AND MAP READING

The Science of Geography.—Geography is the science which deals with the distribution of various phenomena over the Globe, as for example with the distribution of land and water, of rainfall, of products, and of peoples. Everything which goes to make up man's environment forms part of the subject of geography, and those phenomena are most important which most affect his development and distribution. Thus the distribution of fertile plains is more important than that of snow-capped peaks, the distribution of coal than that of diamonds, the distribution of rivers than that of glaciers. It is not merely necessary to describe these various distributions, their causes and consequences must also be traced out. The following illustration shows how far-reaching such consequences may be. In eastern North America, the Appalachian mountain system consists of a series of parallel ridges and valleys running from north-east to south-west; the cause of this relief is the nature of the rocks which form the surface: bands of hard and soft rocks lie side by side, and the ridges correspond to the harder rocks which have been worn away very slowly, while the valleys correspond to the softer and more yielding rocks. Such a series of ridges is difficult to cross, and, as a consequence, the Appalachians, though not lofty, for a long time formed a barrier to communication between the eastern sea-board and the interior plains. The British colonies on the sea-board were therefore compact instead of being scattered, and this gave them strength in their warfare both with the French and later with the English government in the War of Independence. Now that railways have been constructed across the Appalachians the effect of the ridges is still apparent, for transport is only easy where the valleys of

the Mohawk and Hudson rivers form a natural road; hence, at the seaward end of this road has developed New York, by far the greatest port of the continent.

Geography makes use of the main conclusions arrived at in many other branches of science, notably Geology, which deals with the Earth's crust, and Meteorology, which deals with its atmosphere, and it is itself of great importance in explaining the course of historical and political events.

Maps and Map Scales.—Distributions can be shown graphically by means of maps, which are representations on a small scale of the features of the Earth's surface. The scale to which a map is drawn is usually expressed as the ratio of a distance on the map to the corresponding distance on the Earth's surface; for example the scale may be 1 : 50,000,000, that is to say, one inch on the map represents fifty million inches or about 790 miles on the globe. What are known as "large-scale" maps, showing surface features in great detail, are constructed in countries which are well surveyed. Such for example is the Ordnance Survey Map of Great Britain, which is on a scale of 1 : 63,360, or 1 inch to a mile; a portion of such a map is shown in Fig. 2. Ordnance maps on smaller scales, e.g. 2 miles to an inch or 10 miles to an inch, are useful for a more general study, while those on larger scales, e.g. 6 inches to a mile or 25 inches to a mile, should be used for very detailed work on a particular region.

Direction on a Map.—The cardinal points (north, south, east and west) showing direction, are fixed relatively to two imaginary points on the Globe, the north and south poles. It is customary so to draw a map that the top of the map corresponds to the north, the right hand to the east, and so on, but this is not always the case, a map of the polar regions being often drawn with the pole in the centre; thus, if it is the north pole all lines pointing towards the centre are pointing northwards, while all pointing away from the centre and towards the margin of the map are pointing southwards.

Varieties of Maps.—The number and variety of maps are very great. They may show simply the surface features: the coast line, the rivers, the heights and depths as regards sea-level; these are called orographical maps. They may show the rocks which

come to the surface, or the soils covering them, as is done on geological maps. The works of man, such as boundary lines, towns, railroads, are generally shown on what are known as political maps. A large number of climatic maps can be drawn, dealing with the condition of the atmosphere, e.g. its temperature, humidity, and currents, while biological maps form another series, showing the distribution of types of vegetation, animals, and men. Yet another important class are the economic maps which deal with the ever-changing conditions of production and transport of commodities, and density of population. Examples of most of these maps will be found in later sections of this book.

Uses of Maps.—Maps form the readiest means of comparing one region with another, and it is especially useful to compare similarly situated regions, as for example Western North America and Western Europe, in order to see what features they have in common.

The comparison of two or more maps serves to bring out the causal connexion (i.e. the connexion as regards cause and effect) between the various distributions, as for example between the abundance of vegetation and the abundance of rainfall, between the temperature and the kinds of crops, or as in the case of Canada, between the routes followed by the railways and the density of population.

As the distribution of relief, that is to say, of heights, depths and slopes, has the most far-reaching consequences of any of the natural features of the Earth's surface, a good orographical map should be in constant use, and all other maps should be used in conjunction with it.

The Ordnance Map.—The portion of the one-inch ordnance map shown in Fig. 2 will now be considered in detail. This map shows a portion of the South Downs, with the river Arun flowing southward past Arundel Castle towards the English Channel.

Relief. Two methods of indicating relief are commonly employed. The first is by hill-shading, or hachuring. Lines are drawn following the direction of the slope of the surface, and are made thick where the slope is steep, fine where the slope is gentle, while where there is no appreciable slope there is no

FIG. 1.—Characteristic Signs used in the Survey.
(Reproduced from the Ordnance Survey Map with the sanction of the Controller of H.M. Stationery Office.)

shading. The second method, employed on present-day Ordnance Maps, is by contour lines, which are drawn through all points having an equal height or altitude above mean sea-level. On this map the lowest contour line is that joining the points fifty feet above sea-level; it can be traced near the foot of the slopes on either side of the Arun valley. The next contour line is 100 feet above sea-level, so that there is a "contour interval" of 50 feet between the two; above this level the contours follow at intervals of 50 feet, the highest on the map being the 600-foot contour line on Rackham Hill, and above this the highest point is 626 feet. On small-scale maps showing large areas the contour interval must be much larger than 50 feet, or the contour lines would become inconveniently crowded; reference to an atlas will illustrate this point. An examination of Fig. 2 shows that on the steep northern slopes of Rackham Hill the contour lines are close

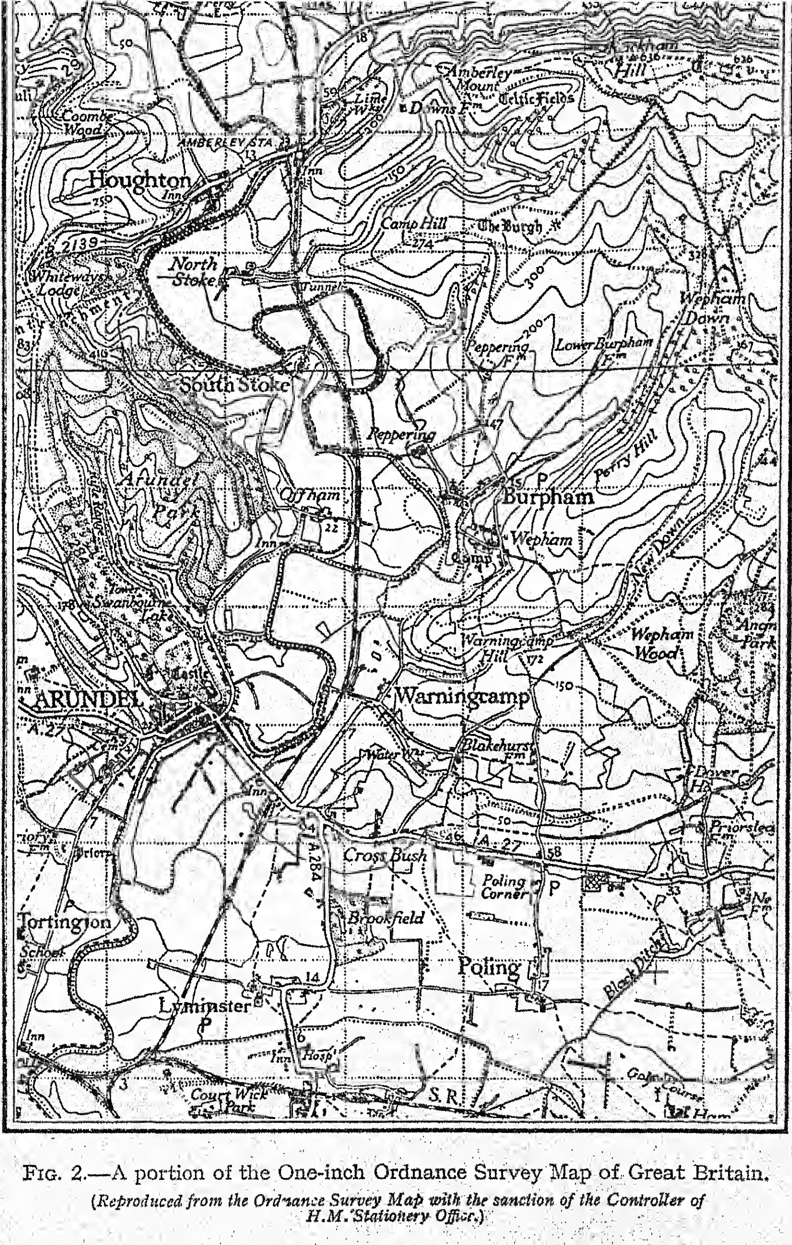

FIG. 2.—A portion of the One-inch Ordnance Survey Map of Great Britain.

(Reproduced from the Ordnance Survey Map with the sanction of the Controller of H.M. Stationery Office.)

together, while on the more gentle southern slopes they are farther apart. The floor of the Arun valley is flat, everywhere under 50 feet, but as regards the section between Amberley and Arundel, a person rowing down-stream would see hills rising sharply from the level meadows whether he looked west or east. On the great bend between Amberley Station and South Stoke he would be immediately under the hill, but after passing Arundel he would see no more hills. Lyminster and Poling lie on a plain, crossed by Black Ditch.

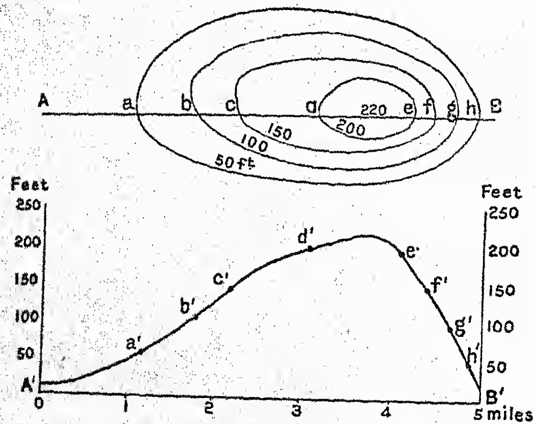

FIG. 3.—Method of Section Drawing.

Sections. In studying a contoured map, the surface relief may be made more graphic by drawing sections along particular lines. Fig. 3 illustrates the method of section drawing. The upper part of the diagram shows an area contoured at 50-foot intervals; the section is to be drawn along AB. A horizontal line $A'B'$ is drawn on squared paper to correspond to AB, and along it the horizontal scale ($\frac{1}{2}$ inch = 1 mile) is marked off; vertical lines at A' and B' are marked with the vertical scale in feet. The points a, b, c . . . show where the section line crosses the contour line, thus a is 50 feet above sea-level, b is 100 feet, and so on. The corresponding points a', b', c' . . . are marked by measuring the correct horizontal distance from A', and the correct vertical distance above the base line; these points a' . . . h' are then joined, the summit being placed at 220 feet as on the

map; the slope $b' a'$ is produced towards A', and the slope $g' h'$ towards B', and the section is complete.

Fig. 4 shows a section across the Arun Valley from W.S.W.

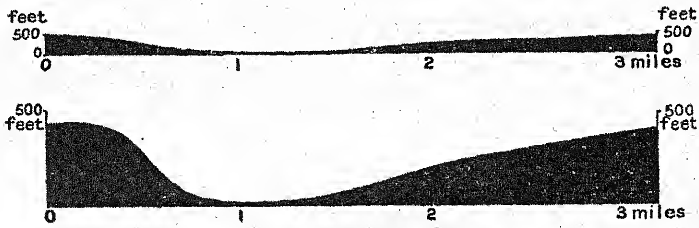

FIG. 4.—Section across the Arun Valley.

to E.N.E. through North Stoke; in the upper diagram the same scale, namely 1 : 63,360, has been used for both distances and heights, but this does not show the relief at all clearly; in the lower diagram the vertical scale is $5\frac{1}{4}$ times the horizontal scale. Here the features brought out are the short steep western slope of the valley, the long gentle eastern slope, and the flat valley floor between them; a reference to the map shows that the river flows close under the steep slope. Although it is generally convenient to exaggerate the vertical scale in section-drawing, this has the effect of making the slopes or gradients appear steeper than they really are, as is seen by comparing the two sections in Fig. 4. The true gradients on the northern slope of Rackham Hill are shown in Fig. 5 (*a*), the horizontal scale in this case being $5\frac{1}{4}$ times that of the map, and equal to the

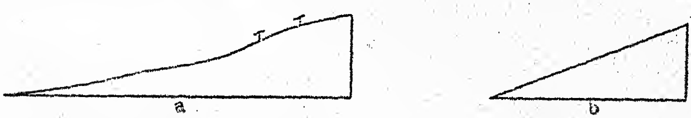

FIG. 5.—(*a*) Gradients on Rackham Hill. (*b*) Gradient of 1 in $2\frac{1}{2}$.

vertical scale. At almost the steepest part (marked near the summit on the figure) the gradient is 1 in $2\frac{1}{2}$, that is to say, an advance of $2\frac{1}{2}$ feet means an ascent of 1 foot. This gradient is illustrated more clearly in Fig. 5 (*b*), where the ascent is drawn as a straight line.

It is not necessary, and not often desirable, to draw a section

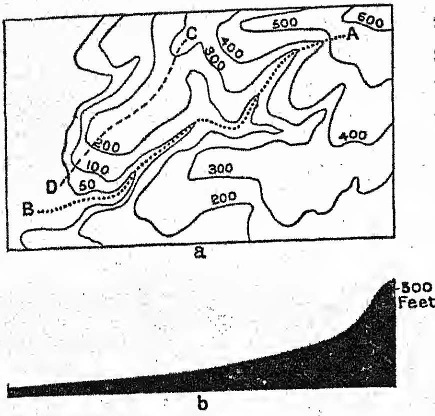

FIG. 6.—Section along a Valley Floor from A to B.

along a geometrical line; some natural line such as a valley floor or the crest of a ridge may be followed. Such a section is shown in Fig. 6. The upper diagram gives certain contour lines of a small portion of the map, namely the area to the south-west of Rackham Hill; the dotted line *AB* follows the floor of a valley which leads to the river Arun, and Fig. 6 (*b*) shows the section along this line. The steep gradients in the upper part of the valley, and the gradual decrease of the gradient towards the lower part, are the main features of this section. The arrangement of contour lines and of slopes in the valley may be contrasted with those of the higher ground *CD*, which forms a spur pointing to the south-west. Here the upper slopes are the more gentle, the lower ones forming the moderately steep edge of the Arun Valley.

Just as the relief of the land can be shown by lines of equal altitude (contours), so the relief of the sea can be shown by lines of equal depth (iso-baths), and sections can be drawn to show the sea-floor. Such a section, drawn from north to south across the Black Sea, is given in Fig. 7, the heights and depths (and therefore the gradients) being much exaggerated.

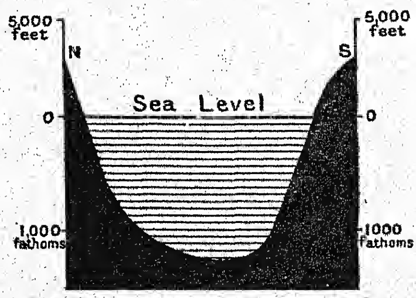

FIG. 7.—Section from North to South across the Black Sea.

Vertical scale greatly exaggerated.

Drainage. The map in Fig. 2 shows the drainage of the land, the chief features being the winding river Arun, and the lake in Arundel Park. It is noticeable that the smaller valleys in the hills are without

streams, while over the flat valley floor of the Arun there are numerous small dykes containing water.

Vegetation. The map also gives some indication of the character of the vegetation, considerable tracts of woodland being shown, and several enclosed parks, such as Angmering Park near Wepham Wood. There are no orchards and no marshland in the area. It is noticeable, however, that the markings to show vegetation tend to obscure those representing the relief, and the two features may with advantage be mapped separately.

Culture. Under the head of "culture" come all the works of man. On a large-scale map, such as that in the figure, buildings can be shown, and the more important, such as churches, inns and wind-pumps, are marked; but on small-scale maps only the positions of the larger towns are indicated. It is clear that on any small-scale map the features omitted must be far more numerous than those inserted, and it is useful occasionally to consult large-scale maps[1] in order to correct the false impressions left by the generalized maps. In addition to buildings, roads, railways, and artificial waterways (in this case cuts from one river bend to the next) are among the more important of the economic features shown on the Ordnance maps.

The National Grid. The small squares covering the map formed by lines running from south to north (Eastings) and from west to east (Northings) are part of the National Grid. Each square covers a square kilometre. Thicker lines, such as that through South Stoke from west to east, are drawn at every ten kilometres. On the complete map sheet all the lines are numbered: that running S. to N. close to Peppering Farm is 504, and that running W. to E. through the Farm is 110. This means that the Farm is just over 504 kms. east, and exactly 110 kms. north, of the "origin" of the grid lines, this origin being a point west of Land's End from which all the numbering starts. The Lime Works, half a km. N.E. of Amberley Station are 503 kms. east and 112·2 kms. north of this point. The grid was designed for military purposes, so that positions could be fixed with the greatest exactness. It is fully described on the covers of the New Popular Edition of the 1 inch Ordnance Survey maps.

[1] Such maps are often issued free or in a cheap form by railway companies, colonial agents, and the Governments of foreign countries.

C. C. Esson and G. S. Philip: *Map Reading made Easy* (Philip).
Bryant and Hughes: *Map Work* (Oxford Press).
A. R. Hinks: *Maps and Survey* (Cambridge Press).

CHAPTER II

THE EARTH AS A GLOBE

The Shape of the Earth.—The familiar fact that when a ship is at a considerable distance across the sea its masts can clearly be seen through a telescope, while its hull is hidden by the water between the ship and the observer, shows that the surface of the water must be curved; there is, as it were, a bulge in the water-surface between the hull of the ship and the observer. The same is true in any part of the world and in any direction in which the ship may be with regard to the observer; moreover, the same appearance of a "bulge" is to be observed on the land where the surface is free from hills, as in the Fen District of England. It may therefore be concluded that the surface of the Earth, apart from the unevenness of hills and valleys, is everywhere curved; in other words the Earth is more or less ball-shaped.

This view is confirmed by watching eclipses when the shadow of the Earth is thrown by the Sun upon the Moon, for the edge of the shadow always forms part of a circle. Such a circular edge might be seen if the Earth were a flat disc, provided that the surfaces of the disc always faced the Sun and Moon respectively; but it is also known that the Earth rotates so that the side which faces the Sun gradually passes round until it faces away from the Sun. If a disc were to rotate in this way, its shadow might at one time be circular, but later it would be elliptical; this may be seen by throwing the shadow of a plate upon a wall and rotating it so that the flat side no longer faces the light. Now since eclipses are seen by people at all parts of the Earth and at different times, and the shadow is always circular, the conclusion is that the Earth cannot be a disc, but must be like a ball.

Another way of realizing the shape of the Earth is to consider the curvature of its surface, first in a north-south direction and then in an east-west direction. If the surface of the Earth were flat, it might be represented by a line such as *abc* in Fig. 8, where *a* is at the north and *c* at the south of a portion of the surface. Imagine that the arrow pointing in the direction from Z^a to *a* represents a ray of light coming from a star vertically downwards upon the surface at *a*; that is, the star will appear to be overhead or in the zenith at *a*. Because the distance from a star to the Earth is so great it would be misleading to show the star itself in the diagram; and as any distance on the Earth's surface is very small in comparison, the arrow which represents the direction of a ray of light from the same star to another point *c* must be drawn parallel to the arrow pointing to *a*; it is therefore drawn in the direction from Z^c to *c*. If the star were near the Earth the two arrows would be seen to diverge as they approached the line *ac*, but the star is at such a great distance that the divergence is so slight as to be inappreciable. Similarly rays of light to intermediate points must be represented by arrows parallel to the other two. Thus it appears that were the Earth's surface flat, the star would appear to be in the zenith at all points if it is at the zenith at any one point.

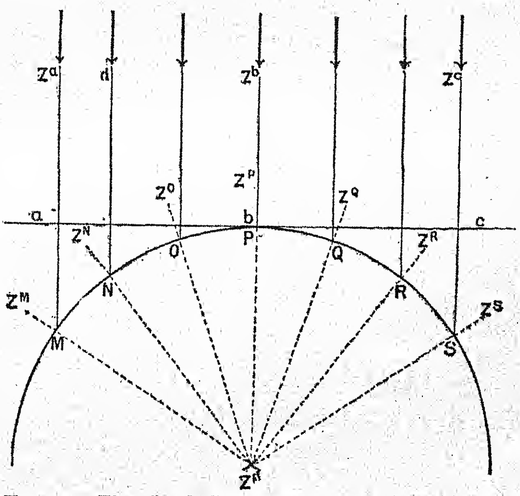

FIG. 8.—The North-South Curvature of the Earth.

Now consider what would be seen if the Earth's surface were curved as *MPS*. The lines prolonging the arrows, namely Z^aM, Z^bP, Z^cS, etc., are parallel, but only one of them strikes vertically

upon the curved surface. At M the line from X (the centre of the Earth) is prolonged to Z^m; if a man stood at M his feet would point "downwards" to X, his head "upwards" to Z^m, which is therefore the zenith at M. Observe that the ray of light does not come from Z^m to M but from Z^a to M, and that there is a considerable angle between the two directions. At the point N, Z^n is the zenith but the light comes from d; again there is an angle between the two directions, but it is now less than at M; while the angle between the star and the zenith is still less at O. As S is the south end of the line MS, at M and N the star appears to be not overhead, but on the south side of the zenith. As a traveller went from M to O, the star would therefore be always somewhat in front of him but would seem to be getting higher in the sky; if he continued his journey it would appear to be overhead when he reached P, and by the time he arrived at Q it would be high in the sky and behind him; as he went onward to S it would still appear behind him, but at a constantly decreasing altitude.

As a matter of fact, as one travels southward the stars do so change their position; this shows that the Earth is not flat in a north-south direction as *abc*, but curved as *MPS*.

The facts as to the rising of the Sun serve to show that the Earth is curved in an east-west direction. Were the Earth flat, when the Sun appeared in the east at one place it would be seen at the same moment at every other place, as an apple could be seen from any point on a table immediately it is raised on one side above the level of the table. But the people to the east of us see the Sun rise before we do, and the people west of us see it rise later than we do; this can be the case only if the Earth is curved in an east-west direction, so that the curvature (or bulging) would hide the Sun from places in the west when it is visible at places in the east.

Thus it is shown that the Earth's surface is curved both in a north-south direction and in an east-west direction (and this double curvature is to be observed in all parts), therefore the Earth must be more or less like a globe or sphere. By various means accurate measurements of the amount of curvature in many parts have been made, and these observations

show that the earth is very nearly a sphere, but that there are slight differences between its shape and that of a perfect sphere; the only difference sufficiently important to be here considered is that there is a slight flattening of the Earth around the points known as the north and south poles. In this and the following chapters the diagrams and the reasoning they illustrate assume that the Earth is a perfect sphere.

The Size of the Earth.—The size of the Earth was calculated by Eratosthenes, a Greek who lived about 200 years B.C.; he based his work upon the knowledge which people even then had that the Earth was a globe in form.

Eratosthenes knew that at noon on a certain day the Sun was vertically above a place called Syene, now Assuan, on the Nile, while at noon on the same day it was not overhead but about 6½° from the zenith at Alexandria, which is nearly 450 miles to the north of Syene. Fig. 9 illustrates this; the arrows show the directions of the Sun's rays, S^1 striking vertically at A (which represents the position of Syene), and S^2 falling on B (which represents the position of Alexandria), and so making an angle of 6½° with the direction of the zenith shown by the line Z^bB.

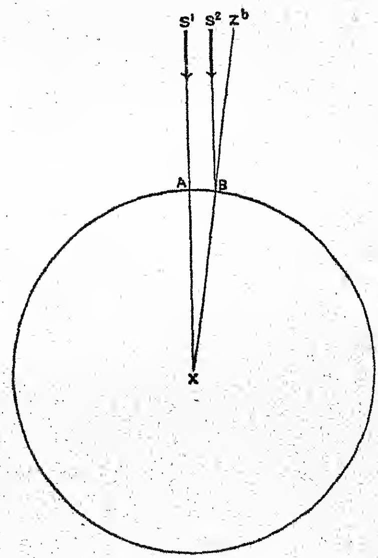

FIG. 9.—Diagram illustrating Eratosthenes' Method of Calculating the Size of the Earth.

The size of the circumference of the Earth may be deduced by the following method. If the zenith lines are prolonged to meet at the point X representing the centre of the Earth, the angle AXB equals the angle S^2BZ^b, and is therefore 6½°. The angle AXB is subtended by the arc AB which is 450 miles long, therefore an angle of 1° would be subtended by an arc of (450 ÷ 6½) miles, and since the whole circle comprises 360°, the circum-

ference equals $(450 \div 6\frac{1}{2}) \times 360$ miles. This reasoning gives the circumference of the Earth as nearly 25,000 miles, and as the diameter of a sphere equals the circumference divided by the constant π (approximately $\frac{22}{7}$), the diameter of the Earth should equal nearly 8,000 miles. This is indeed the case, but since the Earth is not a perfect sphere the diameter through the centre from pole to pole is a few miles less than a diameter at right angles to it, and the circumference measured around the Earth in one direction is not exactly equal to each of those measured around the Earth in other directions.

The Rotation of the Earth.—Every day the Sun appears to rise above the eastern horizon, to climb higher in the sky until midday and then to descend until it sets below the western horizon. By experimenting with a globe it can be seen that this phenomenon might be explained in one of two ways: (i) that the Sun moves round the Earth which remains stationary; (ii) that the Sun remains stationary while the Earth rotates, that is, twists upon a central axis, so that a given point on the globe comes into such a position that from it the Sun can just be seen, continues until it directly faces the Sun, and finally reaches a position from which the Sun is hidden by the curvature of the globe.

The best proof that the second explanation is the correct one was afforded by Foucault, who hung a heavy ball by a fine wire from the dome of the Panthéon in Paris. This pendulum was set swinging in a certain direction, but gradually the direction of the swing appeared to change, for marks made upon the floor occupied successive positions, as aa^1, bb^1, and cc^1 in Fig. 10.

Now a pendulum once started must remain swinging in the same plane until it comes to rest if no force is applied to deflect it, and in the case of Foucault's pendulum care was taken that nothing should so influence it. It was hung from the dome in such a way (see Fig. 10) that it could swing equally freely in any direction and in such a way that if the dome itself were turned round the plane of the swing would not be affected. Therefore,

as no force whatever acted upon the pendulum it was evident that as the plane of its swing remained unchanged the marks on the floor indicated that the floor itself, with the building and indeed the whole Earth, was turning round. This may be the more easily realized if it is imagined that the disc under the pendulum in Fig. 10 is gradually turned round in the direction indicated by the arrow, so that although aa^1 is below the pendulum at first, bb^1 and cc^1 occupy the same place as the rotation proceeds.

Other experiments and observations also prove that the phenomena of day and night are caused by the rotation, every twenty-four hours, of the Earth upon an axis.

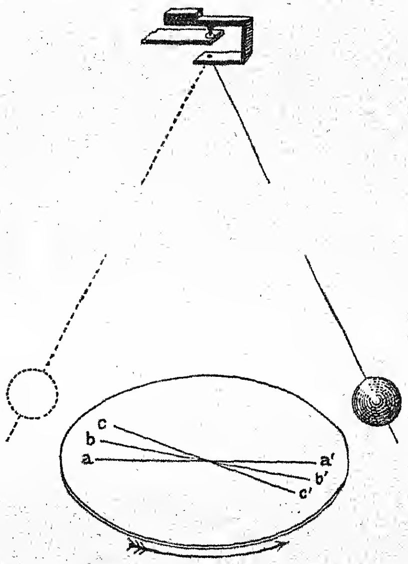

FIG. 10.—Foucault's Pendulum.

Latitude.—This axis is of course no different in structure from any other part of the Earth, but, as will be seen later, the ends of the axis, which are known as the north and south poles, are points on the surface which in some ways are different from any others. If a line were imagined to be drawn around the Earth so that at every point it is half-way between the two poles it would mark out the equator, another part of the Earth's surface of great importance. Other circles may be imagined to be drawn around the Earth parallel to the equator; such circles if drawn at definite intervals between the equator and the poles, would serve to mark the distance from the equator of any place on the surface. This distance from the equator is known as the latitude of the place, and the parallel circles by which it might be marked are therefore called parallels of latitude.

If the quarter of the circumference of the Earth between

the equator and the north pole were divided into 90 sections, each section would be an arc subtending an angle of 1° at the centre of the Earth, for the whole circumference subtends 360°. Hence the distance between places which lie north and south of one another may be measured along the arc either in miles or in degrees of the angle subtended at the centre. The latter is the usual method, and the latitude of a place is expressed as so many degrees north or south of the equator (see Fig. 11).

Fig. 11 shows an imaginary section through the centre of the

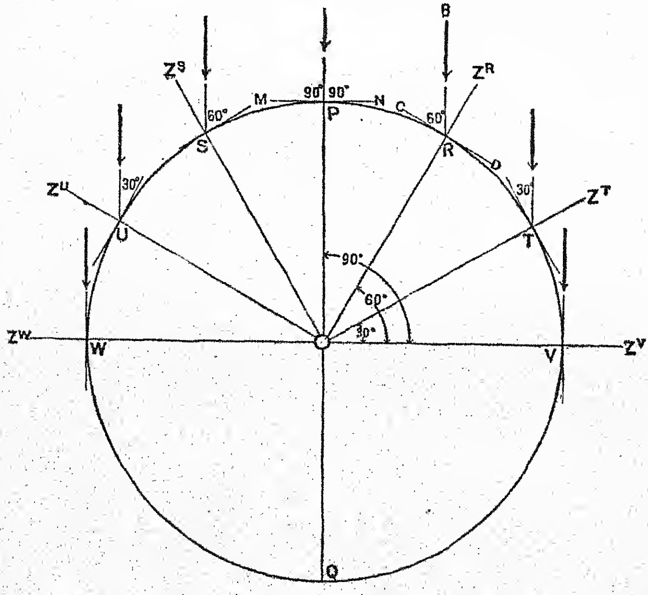

FIG. 11.—The Relation between Latitude and the Altitude of the Pole Star.

Earth, cut through from pole to pole so that the circle *PVQW* is the circumference, *O* the centre, *PQ* the axis and *WV* the plane of the equator, that is, the plane which passes through the centre and cuts the surface along the equator. Assuming the Earth is a perfect sphere, consider the latitude of the points marked upon the circumference. The north pole, *P*, is seen to be the point farthest from the equator in the northern hemisphere and

it has, therefore, the greatest latitude. This can be measured by imagining a line drawn through P to the centre O; the line PO makes an angle of 90° with OV, and we measure the latitude of P by this angle, saying that its latitude is 90° north of the equator. Similarly at the point R the latitude is 60°, for ROV is an angle of 60°, while the latitude of T is 30° for the same reason.

The position of the zenith at P is indicated by producing OP to Z^P, and if at P a line MN is drawn at right angles to the zenith line (and therefore at a tangent to the circle) MN represents a horizontal line (that is, a line pointing to the horizon) at that place. Similarly CD represents a horizontal line at R, C being the north end and D the south end of the line.

At P (the north pole) a man would see in the zenith a certain star, which is therefore named the Pole Star. The angle between the Pole Star and the horizon is therefore Z^PPN or Z^PPM, in each case 90°; in other words the altitude of the Pole Star is 90°. Since this star is at an enormously great distance the arrows which in the figure represent rays of light from it to different parts of the Earth are drawn parallel. Obviously a man standing at R would not see the star in his zenith (Z^R) but at B, and therefore the Pole Star would appear to be at an altitude of 60° above the northern point of his horizon, for BRC is an angle of 60°; note that this angle is also the angle of his latitude. It can be shown by geometry that the height of the Pole Star above the horizon must at any place be equal to the latitude, and this is obviously the case in regard to the point T, while at V, a point which is on the equator and has therefore a latitude of 0°, the Pole Star has no altitude, for it is seen just on the horizon.

Hence to find the latitude of a place in the northern hemisphere the height of the Pole Star above the northern point of the horizon may be observed; in the southern hemisphere, where the Pole Star cannot be seen, the stars there visible may be utilized, but there is a slight complication due to the fact that no one star is just above the south pole.

Longitude.—To define the position of a place on the Earth's surface we need to know not only on what parallel of latitude it is, but also its position on that parallel. For that purpose we

may imagine a circle drawn through the two poles; such a circle is imagined to go through Greenwich and that half-circle which passes from the north pole through Greenwich to the south pole is called the meridian of Greenwich. This line is a north-south line crossing all the parallels of latitude, and so from it distances along any parallel may be measured either eastward or westward. The whole distance around the Earth along a parallel is 360°, so that if 360 meridians were drawn from pole to pole at equal distances they would lie 1° apart, 180 being east of Greenwich and 180 west of Greenwich. (See Figs. 12 and 13,

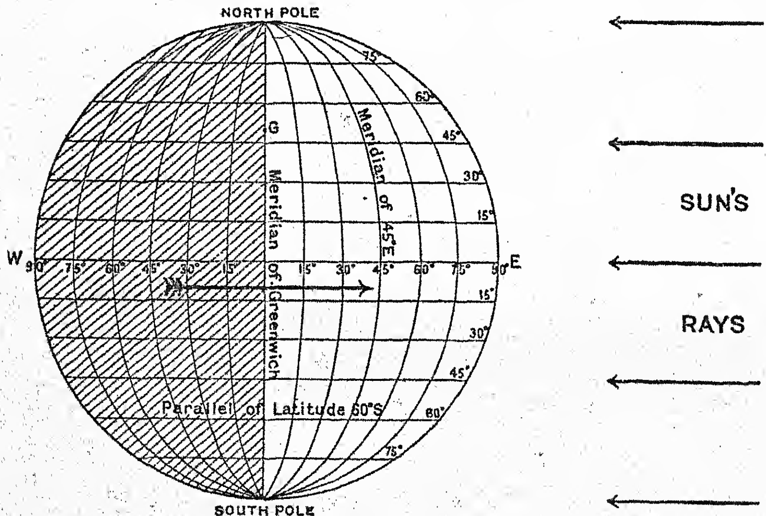

FIG. 12.—Parallels of Latitude and Meridians of Longitude.

in which *G* represents the position of Greenwich.) Hence the east-west position of a place may be stated by saying on what meridian it is situated; for instance, it may be on the meridian which lies 30° east of the meridian of Greenwich and we should then say that its longitude was 30° East. Thus if a place is known to be in latitude 45° S., we know that it is on the parallel which lies half-way between the equator and the south pole, and if it is also known to be in longitude 120° west, we know that it is one-third of the distance around that parallel reckoning westward from the meridian which passes through Greenwich.

The meridian of Greenwich is the one from which longitudes are usually calculated; in other words, it is usually considered the prime meridian, but some nations employ other meridians for this purpose.

Longitude and Time.—If one imagines that at a certain moment the Earth has rotated so that the rays from the Sun light up the half of the Earth which is east of the meridian of Greenwich (see Figs. 12 and 13), observers at places on the meridian of 90° E. have the Sun immediately opposite to them,

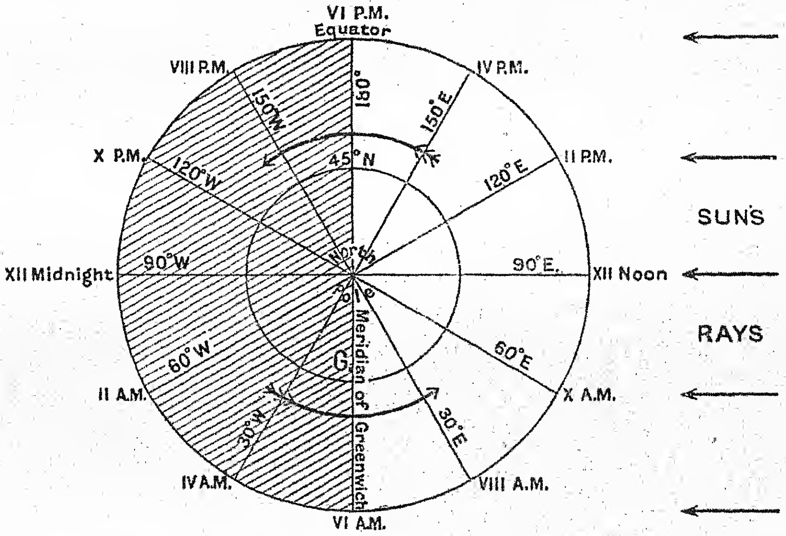

FIG. 13.—The Relation between Longitude and Time.

so that the Sun appears to them to be at the highest point in its daily course; that moment they would call "noon."

As Greenwich is on the boundary of the light and dark portions, the Sun appears at Greenwich to be neither quite above the horizon as at places east of Greenwich, nor quite below the horizon, and therefore invisible, as at places west of Greenwich, that is, the Sun is just on the horizon. Further, as the Earth is rotating from west to east (the direction is shown by the large arrows in Figs. 12 and 13), Greenwich is about to enter the light, so that it is dawn at Greenwich. Similarly it may be seen

by reference to Fig. 13 that it is sunset at longitude 180° and midnight at 90° W.; the hours at these and certain other meridians are shown in Fig. 13.

Thus there is a definite relation between longitude and time; as the Earth rotates through 360° in twenty-four hours, a difference of 15° of longitude corresponds to a difference of one hour in time.

If, therefore, at a certain place the Sun appears at the highest point of its course so that the time is said to be noon, and at the same time the clocks at Greenwich indicate that the hour there is 9 a.m., there is a difference of three hours between the time of the two places and consequently a difference in longitude of $3 \times 15°$, or 45°. It remains to ascertain whether the place is at 45° E. or 45° W. of Greenwich. Since the place has rotated to a position opposite the Sun (and therefore has noon) three hours before Greenwich, it must be east of Greenwich.

Thus the longitude of a place can be calculated if the time at the place (the local time) can be compared with Greenwich time; sailors can find local time by observations of the Sun, and Greenwich time by carrying a chronometer (a very accurate timepiece) which keeps Greenwich time throughout their journey. For example, if the sailor's observations of the Sun showed that local noon occurred when the chronometer showed Greenwich time to be 3.40 p.m., the place would be 55° W. of Greenwich, because Greenwich has rotated into the noon position $3\frac{2}{3}$ hours before the place in question reached that position (note again the direction of rotation as shown in the diagrams).

Since local time varies constantly as one travels east or west and all places east or west of one another have varying local times, it is convenient for all places within a limited area to employ the same time, usually the local time of an important central position, and this is called the standard time. For example, the standard time which is everywhere recognized in Great Britain is the local time at Greenwich; in Ireland the standard time is the local time of Dublin, and as Dublin is in longitude 6° 20′ W., Irish time is about twenty-five minutes slow as compared with Greenwich time. Similarly, North America uses five standard times, known as Atlantic, Eastern,

Central, Mountain and Pacific times, based upon the meridians 60°, 75°, 90°, 105° and 120° W. respectively; consequently a traveller going westward across Canada does not need to alter his watch a varying number of minutes at each place on his journey, but four times sets it back just one hour when he enters another time-belt; having done that he has no further difficulty regarding time. Europe has three standard times differing by one hour, and other regions also have similar recognized times.

Great and Small Circles.—It should be observed that any two meridians which are exactly opposite to one another form a complete circle which divides the sphere into two (equal) hemispheres; any circles bisecting the sphere are called "great circles." The equator is a great circle, but other parallels of latitude are "small circles," for they divide the sphere into unequal parts.

All great circles are of the same size, namely, nearly 25,000 miles long; hence the degrees of latitude, which are $\frac{1}{360}$ of these great circles, are about 69 miles in length. This also is the length of a degree of longitude at the equator, since it is $\frac{1}{360}$ of the equator, but the degrees of longitude in other latitudes are of less length as they are $\frac{1}{360}$ of smaller circles.

The shortest line joining any two points on the surface of a sphere is a portion of the great circle passing through those points, hence sailors often follow "great circle routes."

Thus if a globe be taken and a string drawn tightly from the position of San Francisco to that of Tokyo, the shortest route is marked out. It is a portion of a great circle, but it does not lie along a parallel of latitude although the two places are in nearly the same latitude. The route takes a north-westerly course in leaving San Francisco in latitude 38°, and this direction gradually changes until at about latitude 50° the course tends slightly southward as well as westward, finally becoming an almost exactly south-west course as Tokyo is approached. Similarly in the southern hemisphere the direct great circle route between the Cape of Good Hope and South Australia would take ships nearer to the south pole than if they followed the longer route along the parallel of latitude.[1]

[1] Great circle sailing and flying routes can only be understood if a *globe* is examined; ordinary maps cannot give the correct ideas.

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[1] Great circle sailing and flying routes can only be understood if a *globe* is examined; ordinary maps cannot give the correct ideas.

Terrestrial Magnetism.—The rotation of the Earth is possibly the cause of the Earth acting as a huge magnet, for a compass needle (which is a magnetized piece of steel) has one end attracted towards a part of the Earth near the north pole and the other end attracted towards a part near the south pole. These parts are called the north and south magnetic poles; the north magnetic pole lies beneath the Earth's surface under Boothia Land in British North America. The south magnetic pole lies on the Antarctic Continent, to the west of Ross Sea. Thus although the compass is used to find the true north, in most parts of the world it points somewhat east or west of this direction. For example, in London in 1927 it pointed about 13° to the west of north, that is, there was a magnetic declination or variation of about 13° W., but this variation is very slowly decreasing at the present time. Navigators, therefore, have to take this variation into account and need maps which show what the variation is at all parts of the world. Such maps, called isogonic charts, are issued under the supervision of the British Admiralty every year. The magnetic compass is disturbed by the neighbourhood of masses of steel, iron, or magnetic iron ore, and in regions where much ore occurs the variation or declination is very irregular.

For books for further reading see end of Chapter III.

CHAPTER III

THE EARTH AS A PLANET—MAP PROJECTIONS

The Solar System.—The science of astronomy teaches that the Sun is the centre of a number of bodies which revolve round it in elliptical paths known as their orbits. These bodies are the planets; eight of them are much larger than the remainder, which number several hundreds; the Earth is one of the largest; it is exceeded in size by Uranus, Neptune, Saturn and Jupiter, while Venus, Mars and Mercury are smaller. The Sun itself is greater than any of the planets, and more than a million times as large as the Earth. Viewed from the Earth it seems small because it is at a distance of over 90,000,000 miles; most of the planets are at a still greater distance from the Sun, but Venus and Mercury are at a less distance than is the Earth. The time which the Earth takes to complete a revolution, that is to travel once round the Sun, is about $365\frac{1}{4}$ days; this period is termed a year, and the changes in the seasons which recur every year are due to the revolution of the Earth around the Sun.[1] The planets farther from the Sun have a longer period of revolution than the Earth, while those nearer the Sun have a shorter period of revolution. As the Sun has planets revolving around it, so some of the planets have smaller bodies (satellites) revolving around them. The Earth has one such satellite, the Moon, which is relatively small, being about 2,000 miles in

[1] The terms *rotation* and *revolution* must not be confused. *Rotation* is used to denote the daily twisting of the Earth upon its axis; *revolution* is used to denote the annual movement of the Earth as a whole round the Sun.

diameter; it is at a distance of about 240,000 miles from the Earth, and revolves around the Earth in a period of one month.

The Sun, the planets, and their satellites form the Solar system; the stars, which are visible on a clear night, are other suns at such vast distances from the Earth that they appear very small.

The Revolution of the Earth.—Although the Earth's orbit

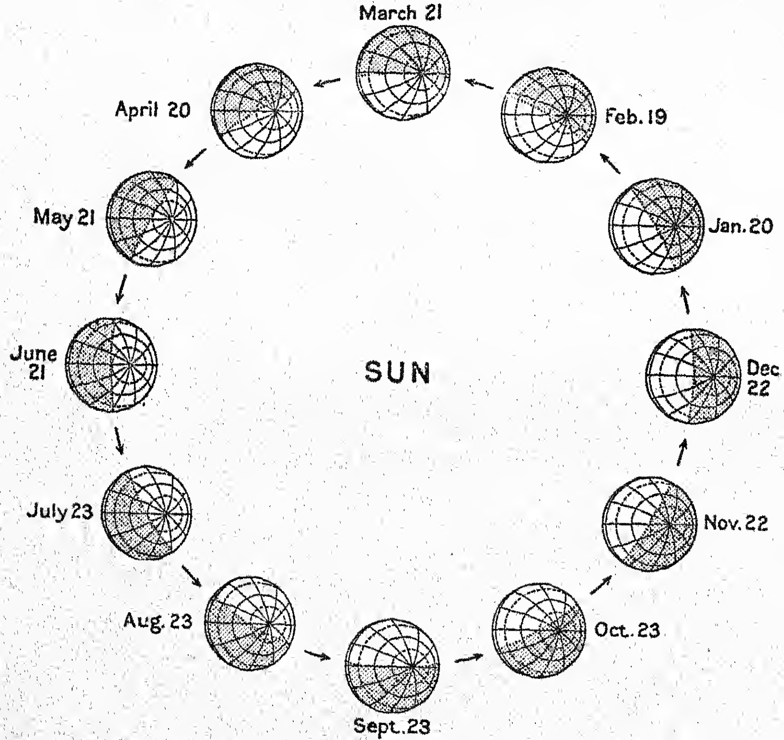


FIG. 14.—The Revolution of the Earth around the Sun.

is elliptical, it is very nearly a circle. The facts as to the revolution may be understood by imagining two globes, which represent the Earth and Sun, floating on the surface of a pool of water, the former slowly moving around the latter. The path of the orbit would be represented by an almost circular line on the surface of the water; the surface itself represents the

plane of the orbit. If a long needle were passed through the Earth-globe to show its axis, it would be inclined so as to make an angle of $23\frac{1}{2}°$ from the vertical, i.e. $66\frac{1}{2}°$ with the surface of the water, for the Earth's axis is inclined to the plane of its orbit at that angle. Moreover, the axis remains parallel to itself during the whole revolution.

These facts are shown by the diagram in Fig. 14; the Sun is not shown in this diagram because it is so much greater than the Earth, and it must be remembered that the orbit is vastly greater in comparison with the Earth than the diagram suggests.

The Duration of Day and Night.—In the December and June positions as shown in Fig. 15, one half of the Earth is illuminated and the other half is dark if no allowance is made for twilight. As a matter of fact the portion of the Earth which is just outside the illuminated area has twilight, but in this study a sharp boundary between the light and dark portions will be assumed to exist. In the March position apparently the whole of the Earth is illuminated, but this is because the half on which the Sun shines is shown in the diagram; the entire half of the Earth not shown is in the dark. Conversely, in the September position the illuminated half of the Earth is not shown.

This diagram [1] is so drawn that in the March and September positions the observer is supposed to be in a straight line with the Earth and Sun. In Fig. 16, however, the observer is supposed to be at right angles to a line joining the Earth and Sun, as though viewing the Earth on March 21 from the position marked ⊕ in Fig. 15. Hence half the Earth is seen to be illuminated and half is in darkness; moreover, the axis inclines $23\frac{1}{2}°$ toward the observer so that the north pole is visible but not the south pole.

Consider first the length of daylight throughout the year at the equator. In the December position in Fig. 15 a point on the equator passes along the line EE as the Earth rotates,

[1] The study of this chapter will be greatly facilitated by the actual use of a globe, even if it is only a small one. The diagrams will suggest how the globe may be used; and text, diagrams and globe should constantly be compared.

so that the left-hand portion of this line represents the time during which the point is in the light and the right-hand portion of the line represents the time during which the point is in darkness. These two portions are equal, and similarly as the point completes its rotation on the side of the Earth not shown in the diagram, it is in the dark portion for half the period and in the light portion for half the period. Consequently, a point on the equator has 12 hours' light and 12 hours' darkness during a complete rotation of 24 hours. In the March position (see

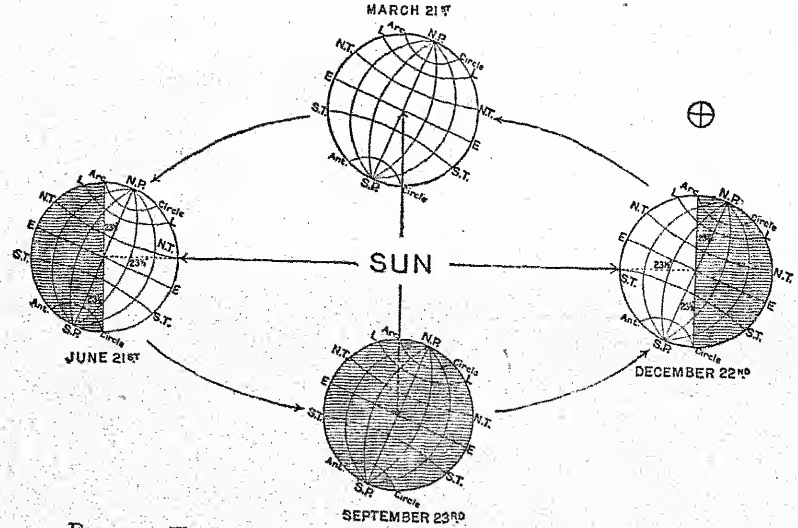


FIG. 15.—The Duration of Daylight at the Equinoxes and Solstices.

Figs. 15 and 16) the same point rotates for 12 hours in the illuminated portion and for 12 hours in the dark portion, while in the June and September positions it has the same equal periods of day and night. Therefore it appears that throughout the year there are 12 hours of light at the equator, and as noon is midway between sunrise and sunset, the Sun rises at 6 a.m. each morning and sets at 6 p.m. each evening.

Next consider the conditions in the latitude of London, that is, $51\frac{1}{2}°$ N.; as the Earth rotates, a point representing London would pass along the line LL in Fig. 15. In the December position about

one-third of the rotation is in light and two-thirds in darkness; daylight therefore lasts about eight hours, the Sun rising at about 8 a.m. and setting at about 4 p.m. In the June position the conditions are very different, about one-third of the rotation being in the darkness and two-thirds in the light; daylight lasts for about sixteen hours, the Sun rising at about 4 a.m. and setting at about 8 p.m. In the March and September positions the conditions are intermediate between those of December and June, for day and night are of equal length, the Sun rising at about 6 a.m. and setting at about 6 p.m.

Now consider the conditions at a point in latitude $66\frac{1}{2}°$ N. This point is on a parallel of latitude which is $66\frac{1}{2}°$ from the equator and $23\frac{1}{2}°$ from the north pole; this parallel is known as the Arctic Circle. As the Earth rotates, the point passes along the line representing the Arctic Circle in Fig. 15. In the December position the point does not enter the illuminated portion, and therefore the whole rotation is in the darkness; only at one moment is it even on the boundary between the light and dark portions. That is, at the Arctic Circle at this time of the year there is no sunlight; the Sun is below the horizon practically the whole of the 24 hours, only just touching it at one moment. In the June position the converse is the case, for the rotation is entirely in the illuminated portion; there are therefore 24 hours of sunlight, the Sun being above the horizon for practically the whole of the period, and just touching it at one moment. That moment corresponds to midnight at places nearer the equator on the same meridian; hence the "Midnight Sun" is visible at the Arctic Circle at this time of the year. In the March and September positions, there are days

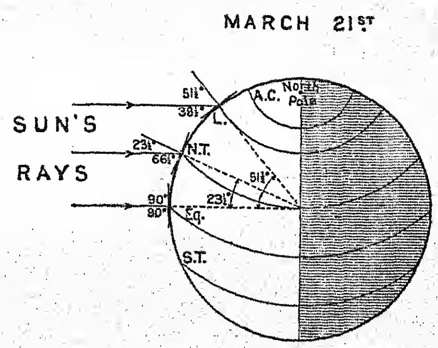


FIG. 16.—The Relation of the Sun's Rays to the Earth at the Equinoxes.

and nights of equal lengths. These facts can also be seen by examining Fig. 14, in which the Arctic Circle is shown by the circle nearest the north pole.

The parallel of latitude 66½° S. is called the Antarctic Circle, and there the conditions are the converse of those at the Arctic Circle, for the period of 24 hours' light occurs in December and that of 24 hours' darkness occurs in June.

Finally consider the conditions at the north pole. There is complete darkness in the December position, and, as is shown in Fig. 14, this darkness persists not merely for one day, but for the whole of the six months between September and March. On March 21 the north pole is on the boundary between the light and darkness (compare Figs. 14, 15, and 16), and from that date until September 23 it remains in the light. There is therefore a " day " of six months and a " night " of six months at the north pole. At the south pole the light period is from September to March, and the dark period from March to September.

It is therefore clear that at the equator there is no change in the duration of day and night throughout the year, and that a change appears and is more marked as the poles are approached. This is shown by the following table giving approximately the longest duration of light and of darkness at certain latitudes.

Latitude.	Longest Duration of Light and Darkness.
0°	12 hours.
30°	14 „
45°	15½ „
60°	18½ „
66½°	24 „
70°	65 days.
80°	134 „
90°	6 months.

It is also apparent that on March 21 and September 23 there are periods of 12 hours' light and 12 hours' darkness at all parts of the Earth. These times are therefore called the equinoxes i.e. equal-night times.

The Altitude of the Sun.—By examining Figs. 15 and 16, it will

be seen that as the Earth rotates on March 21 and September 23 each point on the equator in turn comes under the direct rays of the Sun. Thus at noon at the equinoxes an observer at the equator has the Sun vertically above his head; or in other words, the altitude of the Sun is 90° above the horizon. This is clearly shown in Fig. 16, and the same diagram shows that at no other latitude is the Sun seen overhead. At latitude $23\frac{1}{2}°$ N. the Sun is $23\frac{1}{2}°$ from the zenith, and therefore has an altitude of $66\frac{1}{2}°$ above the south horizon. At the latitude of London

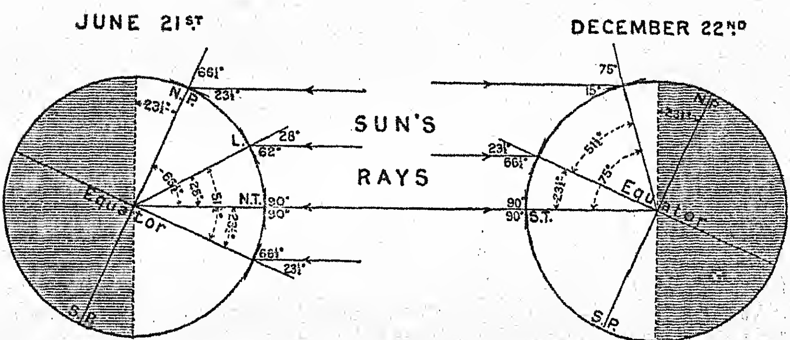


FIG. 17.—The Relation of the Sun's Rays to the Earth at the Solstices.

the Sun is $51\frac{1}{2}°$ from the zenith, and has an altitude of $38\frac{1}{2}°$ above the south horizon; at the Arctic Circle the Sun's zenith distance is $66\frac{1}{2}°$ and its altitude is $23\frac{1}{2}°$; at the north pole the Sun is just on the horizon.

On June 21 the Sun's rays strike vertically upon the Earth, not at the equator, but at $23\frac{1}{2}°$ N. of the equator (see Fig. 17). At the equator itself, the Sun at noon appears $23\frac{1}{2}°$ from the zenith and therefore at an altitude of $66\frac{1}{2}°$ above the north horizon. At London the Sun at noon is more nearly overhead than it is in March or September, for the vertical rays are $23\frac{1}{2}°$ north of the equator; the Sun has therefore a zenith distance of $51\frac{1}{2}°—23\frac{1}{2}°$, that is 28°, and its altitude is therefore 62° above the south horizon. At the north pole, the altitude of the Sun is $23\frac{1}{2}°$ above the south horizon.

On December 22 the Sun's rays strike vertically upon the Earth at $23\frac{1}{2}°$ S. of the equator. At the equator, therefore, the

noon altitude of the Sun is $66\frac{1}{2}°$ above the south horizon. At London the zenith distance of the Sun at noon is now $51\frac{1}{2}° + 23\frac{1}{2}°$, that is 75°, so that its altitude is only 15° above the south horizon. At the Arctic Circle the Sun at noon is just on the south horizon, and at the north pole it is, of course, entirely invisible.

The altitudes in the southern hemisphere can be similarly calculated, but the time of the year is reversed and the Sun is seen above the north horizon instead of the south horizon.

The Apparent Course of the Sun.—(1) *At the Equator.* The diagram in Fig. 18 shows how the Sun appears at the equator at different periods of the year. O represents the position of the observer, and his horizon is shown by the ellipse of which the north, south, east and west points are marked. The zenith line is the dotted line vertically above the point O. On March 21 the Sun rises in the east at 6 a.m., ascends till it reaches the zenith at noon, and sets in the west at 6 p.m. On each successive day it rises slightly farther north of east, reaches a point in the sky north of the zenith, and sets at a point north of west; the path in the sky each day is practically parallel to that of other days, for the changes are very gradual. On June 21 the Sun rises considerably north of east, reaches an altitude of $66\frac{1}{2}°$ above the north horizon (compare Figs. 17 and 18), and sets considerably north of west. This northward movement ceases, however, on June 21, and from that date onward the changes are in the reverse direction, until on September 23 the conditions are again as they were on March 21. June 21 is therefore said to be a solstice, which means a date when the Sun, as it were, stops before the reversal of the changes. From September 23 until December 22 the Sun each day rises farther south of east, and sets farther south of west. On December 22 the altitude of the Sun is $66\frac{1}{2}°$ above the south horizon (again compare Figs. 17 and 18); this day is another solstice, for the southward movement now ceases and thenceforward a northward movement is again to be observed.

The distance north of east of the June sunrise is equal to the distance south of east of the December sunrise, although the fore-shortening in the drawing of the diagram makes the

latter appear less. It should be remembered that at the equator the times of sunrise and sunset are the same on every day of the year.

(2) **At London.** It has already been stated that on March 21 the Sun at noon is $38\frac{1}{2}°$ above the south horizon; this is now shown in the diagram in Fig. 19, which also shows that on the same date sunrise and sunset are due east and west of the

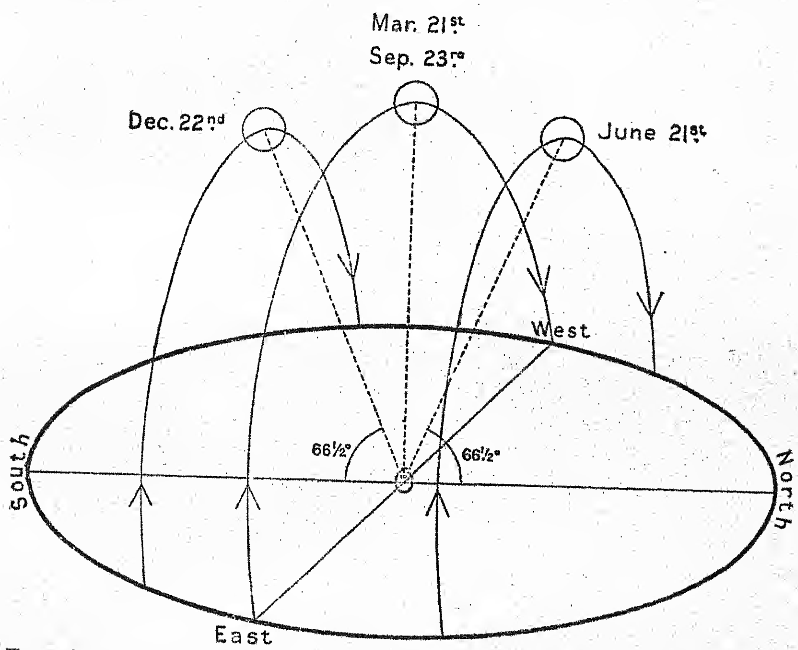


FIG. 18.—The Apparent Course of the Sun in the Sky at the Equator at the Equinoxes and Solstices.

observer. From March 21 to June 21 the sun each day rises farther north of east, attains a greater altitude at noon, and sets farther north of west, so that the path of the Sun is longer each day; these changes correspond to the earlier times of sunrise and the later times of sunset. On June 21 the Sun rises in the most northerly position and at the earliest hour, reaches its greatest altitude of 62° (compare Figs. 17 and 19) and sets

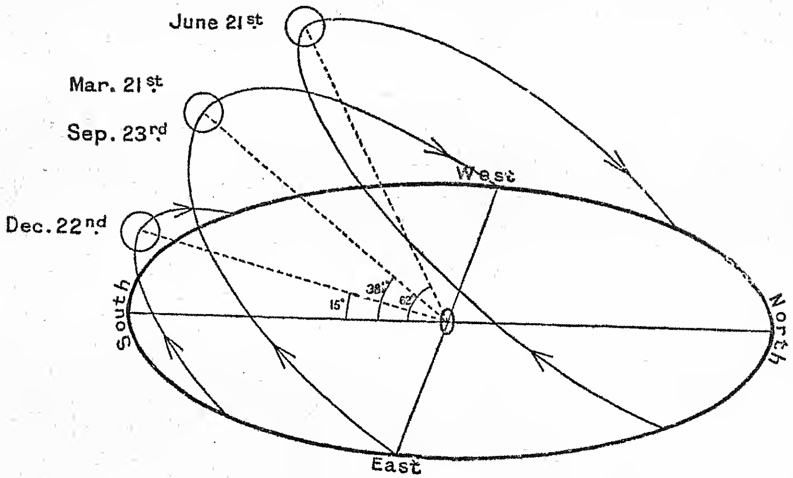


FIG. 19.—The Apparent Course of the Sun in the Sky at London at the Equinoxes and Solstices.

in the most northerly position and at the latest hour. This is therefore the date of the solstice, and since this extended path of the Sun is the cause of summer, June 21 is known in the northern hemisphere as the summer solstice. From June 21 the changes are in the reverse direction until December 22. This is the shortest day and the Sun is at its lowest midday altitude; these conditions are the cause of winter, and December 22 is therefore the winter solstice of the northern hemisphere.

As the conditions in regard to the length of day and the altitude of the Sun are reversed in the southern hemisphere, June 21 is there the winter solstice and December 22 the summer solstice.

(3) **At the Arctic Circle.**—The diagram in Fig. 20 shows that at the Arctic Circle on June 21 the Sun is visible throughout the 24 hours, though at one moment it just touches the north horizon. On March 21 and September 23 it rises due east and sets due west; half of its path is above the horizon and half is below the horizon (this portion being shown by dotted lines on the diagram), so that the daylight lasts for twelve hours. On December 22, although at one moment the Sun is just on

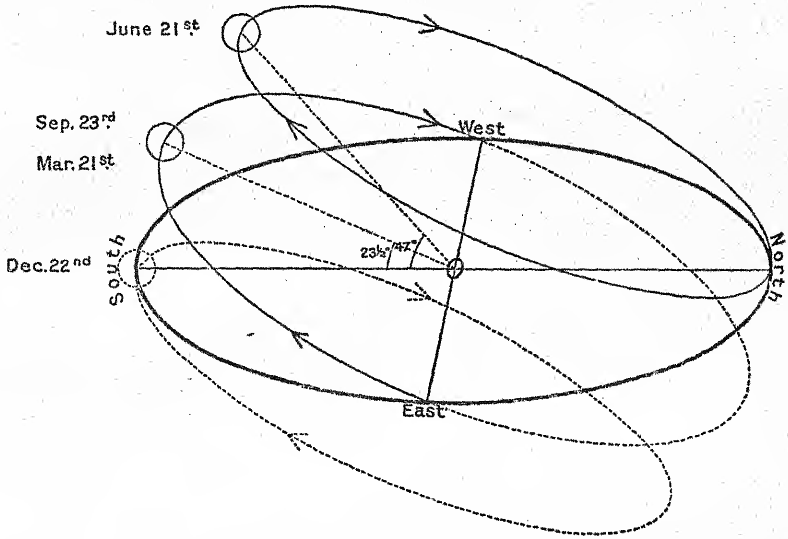


FIG. 20.—The Apparent Course of the Sun in the Sky at the Arctic Circle at the Equinoxes and Solstices.

the horizon, it is invisible for practically the whole of the 24 hours.

(4) **At the North Pole.**—Fig. 21 shows that on March 21 the Sun appears to circle around the observer, all the time being

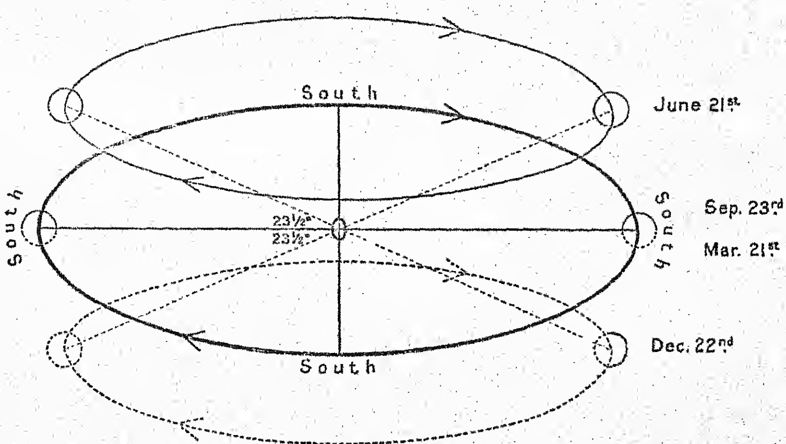


FIG. 21.—The Apparent Course of the Sun in the Sky at the North Pole.

just visible on the horizon. (Note that at the pole itself all lines radiating outward lead to the south.) From this day onward, the Sun continues to circle around in the sky, each day at a greater elevation until on June 21 an altitude of $23\frac{1}{2}°$ is reached. After this date the circling is at a lower elevation and is again on the horizon on September 23; thus the Sun is visible for six months. After September 23 the Sun circles below the horizon, gradually descending until December 22 and then gradually ascending until it reappears on March 21; thus there is a period of six months of darkness.

The Line of Vertical Insolation.—On March 21 the Sun's rays strike vertically upon the equator; in other words, the insolation or radiation from the Sun is vertical upon the equator. Therefore it may be said that on March 21 the equator is the line of vertical insolation. On June 21 the Sun's rays strike vertically upon the parallel of latitude $23\frac{1}{2}°$ N. (refer back to Fig. 17); hence this parallel is now the line of vertical insolation. After this date the Sun turns southward, until on September 23 the equator is again the line of vertical insolation. Hence the latitude of $23\frac{1}{2}°$ N. is a turning point and is therefore called a tropic. Similarly, on December 22 the Sun's rays strike vertically upon the parallel of latitude $23\frac{1}{2}°$ S., so that this parallel is the line of vertical insolation. After this the Sun turns northward, and hence latitude $23\frac{1}{2}°$ S. is also a tropic. To distinguish the two tropics, that of $23\frac{1}{2}°$ N. is called the Northern Tropic (N.T. in Figs. 15 to 17) or the Tropic of Cancer; that of $23\frac{1}{2}°$ S. is called the Southern Tropic (S.T. in Figs. 15 to 17) or the Tropic of Capricorn.

Therefore the line of vertical insolation swings northward from the Southern Tropic on December 22 to the Northern Tropic on June 21, and then swings southward for the same distance during the next six months; it crosses all intermediate latitudes twice in the year, and coincides with the equator on March 21 and September 23.

Determination of Latitude by the Sun.—From Fig. 16 it appears that when the Sun is vertically over the equator, the latitude of a place is equal to the distance of the Sun at noon from the zenith. Therefore on March 21 or September 23 the

latitude of a place can be found by observing the zenith distance of the Sun at noon.

When, however, the Sun is north of the equator, as in June, the Sun is nearer the zenith in the northern hemisphere. (Compare the March position in Fig. 16 with the June position in Fig. 17.) The distance of the Sun north of the equator, called the north declination of the Sun, has therefore to be added to the zenith distance to give the latitude. Thus, as is shown in Fig. 17, on June 21 the Sun's declination is $23\frac{1}{2}°$, and the zenith distance at London is $28°$; these added together give $51\frac{1}{2}°$, which is the latitude of London.

In December, when the Sun is south of the equator and therefore has a south declination, the Sun is farther from the zenith in the northern hemisphere. Therefore the zenith distance is greater than the latitude, and to find the latitude the south declination has to be subtracted from the observed zenith distance. Thus, again referring to Fig. 17, it is seen that on December 22 the Sun's south declination is $23\frac{1}{2}°$ and its observed zenith distance at London is $75°$; the subtraction of $23\frac{1}{2}°$ from $75°$ gives $51\frac{1}{2}°$, which is the latitude of London.

The declination of the Sun for every day in the year is given in the *Nautical Almanac*; sailors therefore can find their latitude at noon on any day by observing the Sun's zenith distance and allowing for the declination. The examples given above apply to places north of the Tropic of Cancer; the method has to be modified in dealing with places between the Tropics and south of the Tropic of Capricorn.

The Moon's Revolution.—The Moon is unlike the Sun and the stars, for it shines only by light reflected from the Sun; therefore only that half of the Moon which is illuminated by the Sun can be seen. As the Moon revolves round the Earth, the illuminated portion appears and disappears. Fig. 22 illustrates this; the outer ring shows that one half of the Moon is always illuminated, and the inner ring shows how this illuminated portion appears from the Earth. When the Moon is between the Earth and the Sun, the dark side faces the Earth and no Moon is visible; this period of the month is called New Moon, for immediately afterwards a "new" Moon begins to appear.

When the Moon has revolved through about one-eighth of its orbit, the illuminated portion presents to the Earth a crescent-shaped appearance. When the Moon has revolved through about one-quarter of its orbit, one-half of its surface is seen; this period is called First Quarter. Later, a gibbous Moon appears when about three-quarters of its surface is visible. Still later, the whole of the illuminated portion faces the Earth; this is the time of Full Moon. Thus from New Moon to Full Moon, the Moon has "waxed"; for the remainder of the month it "wanes," as the diagram shows; the changing appearances are called the Phases of the Moon.

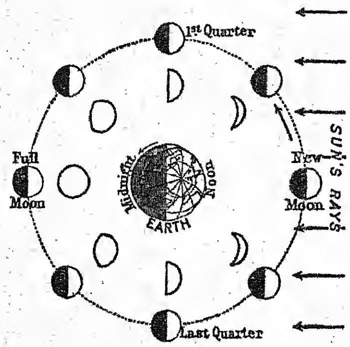


FIG. 22.
The Phases of the Moon.

It should be noted that New Moon and Full Moon occur when the Earth, Moon and Sun are either exactly or almost in the same line, and that at First Quarter and Last Quarter the line from the Earth to the Moon is at right angles to that from the Earth to the Sun.

MAP PROJECTIONS.

A map could be drawn upon the surface of a globe so as to show the shape and relative sizes of the land and water masses accurately, or as accurately as the size of the globe would permit. But if an attempt were made to transfer this map to a flat surface, such as a sheet of paper, the result would inevitably be to distort it in some way. This may be realized by imagining that the map is drawn upon the rind of an orange and that it is then attempted to press the rind, with the map upon it, on a flat surface; it is impossible to do this unless the rind is cut into several parts, and even then the parts cannot be made to join together when laid out. Only if the orange-rind were perfectly elastic, so that some portions of it could be enormously stretched, could the map be shown in one piece, and in that case the stretching would very seriously distort the shape of portions of the map.

It follows that since a map cannot be transferred without distortion from the surface of a sphere to a plane surface, all maps are in some way and to some extent distorted. The inaccuracies are greatest when a map showing the whole World is attempted, less when only a hemisphere is concerned, and smaller still when single countries or smaller areas are mapped; but in every case there must be some distortion.

It is therefore necessary to recognize and allow for the distortions when these are great, and so two commonly employed projections, or flat representations of the Earth's surface, will be examined.

The Mercator Projection.—Fig. 23 shows a map drawn on the Mercator projection. It is apparent that all the parallels of latitude are made of the same length as the equator, whereas on a globe they decrease in length towards the poles; hence there is an east-west stretching on this map at every part except the equator, and this stretching becomes greater with the distance from the equator. Thus on the globe the parallel of latitude at 60° is half the length of the equator, consequently the stretching on the map is two-fold at that latitude. Now the principle on which the Mercator projection is constructed is that of "equal stretching," and so where the east-west stretching is two-fold a two-fold north-south stretching is also made. Hence a small area of one degree each way situated at latitude 60°, is on the map stretched to twice its length and twice its breadth, and therefore to four times its area as compared with an area of one degree each way situated at the equator.

Moreover, as the parallels of latitude are still more stretched nearer the poles, the north-south stretching is equally exaggerated; indeed the exaggeration becomes so gross that maps on the Mercator projection are very seldom shown beyond 80° from the equator, for here the stretching is about six-fold in each direction. The progressively increasing north-south stretching can be seen if one compares the distances between the latitudes 0°, 20°, 40°, 60°, and 80°. The effect of area-distortion can be seen if Greenland is compared with South America; on the map Greenland appears somewhat the larger, but really the area of South America is more than twelve times that of Greenland.

Thus areas and distances are distorted on this map, but on the other hand the principle of equal stretching ensures that "compass-bearings" are represented truly. Thus a north-south line at any part is parallel to a north-south line at any other; similarly a line running from north-west to south-east is parallel to any other line running from north-west to south-east. This is an advantage if true directions are required, as in comparing winds and currents in different parts of the world; hence for

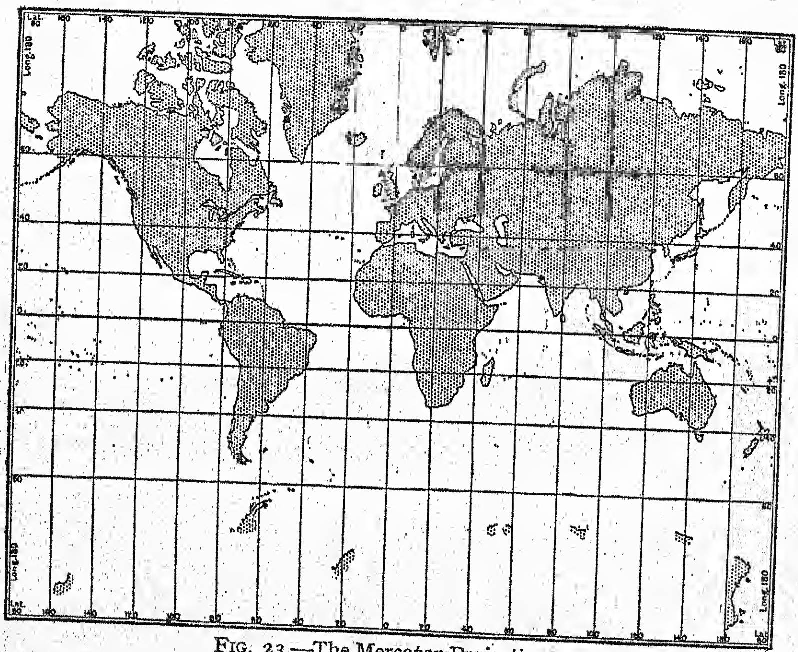


FIG. 23.—The Mercator Projection.

climatic maps the Mercator projection is sometimes advisable, and it is therefore employed in Figs. 71, 72, 78, and 79. For sailors also it is a very useful map, but the exaggerations of distances and areas, and the consequent distortions of the shapes of the larger land and water-masses, make it unfit for extended use.

The Mollweide Projection.—Another projection, the Mollweide projection, is shown in Fig. 24. The central meridian

should be compared with that of 180° on the eastern margin of the map or that of 180° on the western margin. The central meridian is a straight line, while the marginal meridians, which are also north-south lines, are curved, and consequently this projection is not direction-true; again, the marginal meridians are much longer than the central one, although on the globe all meridians are of equal length, and so distances are not truly shown. For both these reasons the Mollweide projection is not suitable for sailors' use.

Next observe the areas adjoining the central and marginal meridians respectively between latitudes 40° and 60° north.

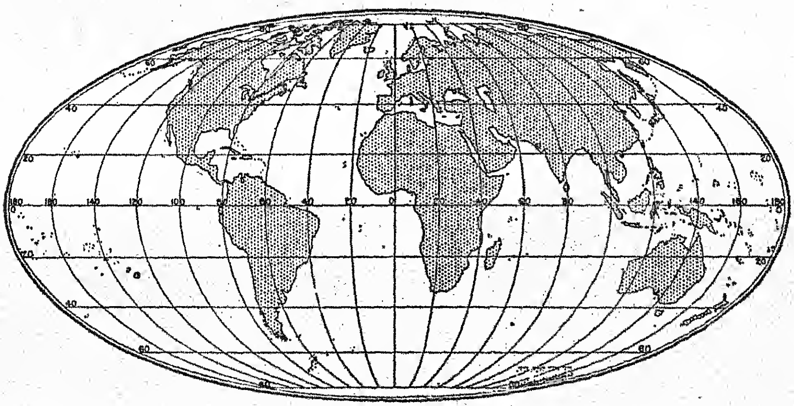


FIG. 24.—Mollweide's Equal-Area Projection.

The marginal areas appear to have been pulled out length-wise and curved, but also they are narrower than the central areas; that is, the north-south stretching has been compensated by an equivalent east-west compression so that the area of the marginal portions has been made equal to that of the central portions. In a similar way, the areas at all parts have been adjusted, so that this projection is an "equal-area" one, showing the areas of countries correctly although their shapes are distorted. (Compare the apparent areas of Greenland and South America.) The Mollweide projection is therefore satisfactory when it is required to show the distribution of phenomena in which the area covered

is important, as in the case of types of vegetation, or peoples and empires.

Moreover, the distortions of shapes, directions and distances are greatest on the margins, and as the map can be constructed to show oceanic and polar regions on the margins and the more important parts of the land regions near the centre, this is perhaps the best projection for use in studying World geography, except either in connexion with climatic conditions which are closely

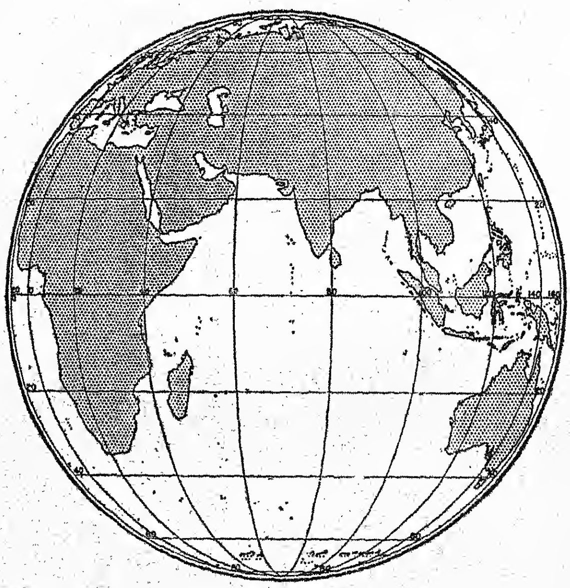


FIG. 25.—The Orthographic Hemispherical Projection.

related to wind-directions, or in connexion with ocean-currents where also true directions are desirable. Thus the maps in Figs. 95 and 104 are drawn on the Mollweide projection, and those in Figs. 71 and 78 on the Mercator projection.

Hemispherical Projections.—If a globe is viewed or photographed from a distance so that only one hemisphere is seen, it might be expected that a true idea of distances, shapes, and areas would be obtained. A map so formed would be identical with that shown in Fig. 25, and if the east-west spaces between the meridians and the north-south spaces between the parallels

are examined they will be seen to decrease from the centre outwards; in other words, the margins of the globe are fore-shortened as they recede from the spectator. This projection (called the Orthographic) therefore distorts distances, directions, shapes and areas. An equal-area hemispherical projection (Lambert's) appears in Fig. 26; here the relative sizes of the areas are correctly exhibited, but a comparison of the network of the parallels and meridians shows that, as in the case of the Mollweide, except at the equator there is a north-south stretching

FIG. 26.—Lambert's Equal-Area Hemispherical Projection.

and east-west compression of the right and left margins as compared with the centre.

Other Projections.—A very great number of projections have been devised, all having their peculiar advantages and disadvantages. In maps showing the whole world or a hemisphere the distortions should be noted and allowances made, but in maps of small areas the distortions are less marked and except in advanced geographical work are not seriously misleading. A common projection for the smaller areas is the

"conical" (see Fig. 27), which might be produced by placing a cone of paper upon a hollow glass sphere which has a map drawn upon its surface and a light at the centre. The lines of the map would be projected on the cone, and if they could be there retained when the paper was unrolled, a conical projection would be the result. Where the cone touches the globe, along the parallel of latitude C in Fig. 27, the distances on the cone and the globe are equal, but north and south of this parallel the cone stands away from the globe and distances on it are greater than those on the globe. This projection is therefore accurate only along the one parallel, and is known as the "one-standard parallel" projection. The distortions are not very great for a small area such as that shaded in the figure, and are reduced on several "modified conical" projections, such as are commonly employed in maps of countries in atlases. For example, there is a "two-standard parallel" projection in which distances are made accurate along two parallels, as though the cone, instead of just touching the globe, cut into it along a parallel between B and C and came out again along another parallel between C and D. Bonne's projection and the polyconic projection are modifications in which the distances between the meridians along every parallel are made equal to those distances on the globe, when the meridians become curved lines.

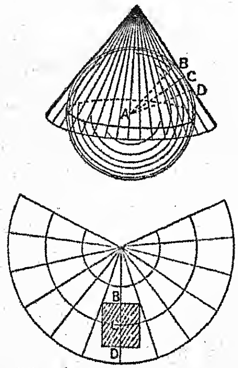


FIG. 27.
The Conical Projection.

BOOKS FOR FURTHER READING.

Hinckley: *Map Projections by Practical Construction* (Philip).
Goodall: *The Globe and its Uses* (Philip).
A. Stevens: *Applied Geography* (Blackie).
A. R. Hinks: *Map Projections* (Cambridge Press).
Jameson and Ormsby: *Elementary Surveying and Map Projections* (Pitman).
J. A. Steers: *Introduction to the Study of Map Projections* (University of London Press).

CHAPTER IV

THE EARTH'S CRUST AND THE FORCES THAT SHAPE IT

A section of the Earth from the outer limits of the atmosphere to the centre is shown in Fig. 28. The atmosphere becomes more and more rare with increasing altitude, so that it is difficult to say where it ends; it may be taken as extending from 100 to 150 miles. The radius of the Earth is nearly 4,000 miles; the crust of solid rock which forms its surface has been estimated to have a thickness of 50 miles, but since the deepest boring actually made into it is less than $1\frac{1}{2}$ miles, no exact calculations can be made. The fact that molten rock is poured out from volcanoes suggests that at a certain depth the solid crust is replaced by plastic material termed magma. This is borne out by observations made in mines and borings which show that temperature increases with depth at such a rate that the fusing point of the most resistant rocks must soon be reached. The physical state and composition of the central core of the Earth are matters of controversy.

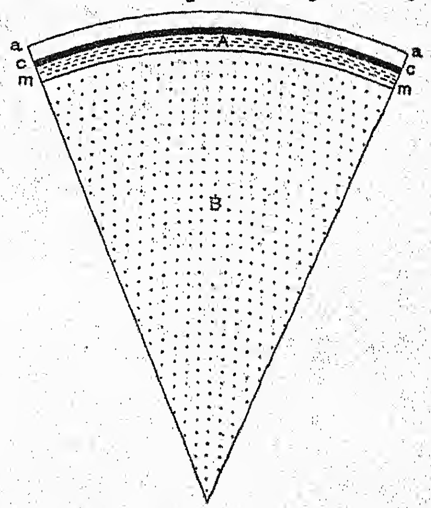


FIG. 28.—Ideal Section of the Earth. (*After Supan.*)
Scale 1 : 100,000,000.
aa, Limit of Atmosphere. cc, Solid Crust. A, Magma. B, Central Core.

Indirect observations show that it must be denser and more rigid than steel, but that the innermost section is liquid.

Formation of Rocks.—Although some of the rocks now forming the Earth's surface are very ancient, it is probable that nowhere is any part of the original crust to be seen. The present rocks have been formed from the original rocks, but are not identical with them. There has been a continuous cycle of changes since the waters first collected in the depressions of the crust to form the oceans.

From earliest times these waters must have evaporated in the heat of the sun, so that water vapour was carried landwards by the planetary winds, and condensed as rain, only to be borne back to the sea by rivers. The running water carried with it fragments and particles of rock, and deposited them in the ocean. Thus deep layers or strata of sediment—mud, sand, and gravel—were formed. Some of these sediments were hardened and rendered compact by the pressure of layers above them, and the particles of others were cemented together by the salts (e.g. of iron) contained in mineral waters which percolated through them; thus inorganic sedimentary rocks were formed such as clays, shales (hardened clays), and sandstones. When life appeared in the oceans the hard shells and skeletons of the marine organisms accumulated in vast beds, which when hardened and cemented formed organic sedimentary rocks such as limestones.

Crustal Movements.—If the wearing away (erosion) of rocks and their deposit elsewhere continued without interruption, the continents would be worn to plains, and the oceans filled. The enormous thickness of the beds of oceanic sediment shows, however, that the ocean floor must have gradually sunk, so that the water became no shallower by the addition of fresh sediment. It is possible that the overloading of one part of the crust by intense sedimentation and the relief of pressure in another part by erosion and denudation may cause a subsidence in the one case, and an uplift in the other. The rock waste brought down by rivers is not carried very far out to sea, but is deposited in a comparatively narrow belt, 100–200 miles wide, round the continents. It has been calculated that whereas the average rate

of denudation is one foot in two or three thousand years, that of sedimentation is one foot in less than three hundred years. Hence, owing to the over-loading of the Earth's crust along this belt, a considerable subsidence may be brought about, so that the lower strata sink nearer and nearer to the level at which a molten magma is found. They are then subjected to great heat, in addition to the great pressure of the layers above them. They are also impregnated with liquids charged with minerals and salts which come from the layer of magma. The result is that they are greatly altered, both chemically and physically, and, when cooled by re-elevation, form hard rocks of a more or less crystalline

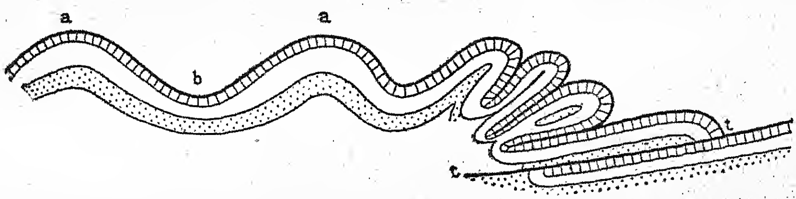


FIG. 29.—Folded Strata. a Upfold. b Downfold. tt Overthrust. (*After de Martonne.*)

nature, such as marbles which are derived from limestones, slates which are derived from clays and shales, and gneisses and crystalline schists which are derived from various rocks. Such altered rocks are known as metamorphic.

The Earth's crust is obviously not in a stable condition, but is subjected to stresses (pressures and tensions) which, owing to the varying rigidity of the different rocks, may cause upward, downward, oblique, or horizontal movements of parts of the crust. These are by some held to be due to the shrinkage of the Earth as it cools, so that adjustments of the crust are necessary, but this cause alone seems insufficient.

The ocean margins being regions of intense sedimentation and metamorphism appear to constitute lines of weakness, so that here the deformation due to crustal stress takes place in a marked degree. The rock-layers are contorted and thrown into a series of ridges and furrows; the ridges or upfolds may be squeezed together or perhaps bent over sideways and piled one upon another (see Fig. 29). These folded masses rise

above the level of the ocean forming new land, while the displaced waters flow over the lowlands of the original continents. Where the rocks resist folding they may be fractured, and one mass thrust horizontally over another (see Fig. 29). The heat developed by friction during such an overthrust may be sufficient to cause the formation of metamorphic rocks from the adjacent layers. It is clear from the figure that after an overthrust or an overturning of folds the rocks no longer rest upon one another in the order in which they were laid down, but older strata may be found resting on younger. Outside or on the borders of the folded region the stresses in the more rigid masses of rock give

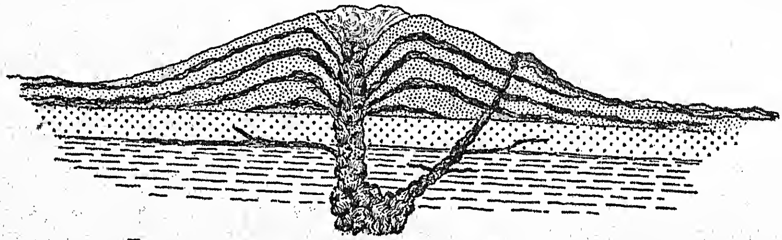


FIG. 30.—Section of Volcanic Cone of ashes and lava.

rise to fractures, and gradual subsidence or uplift takes place along the line of fracture. As a result vast areas of the old continents sink gradually to a lower level and may be inundated by the ocean, while other blocks are uplifted and form fresh highland areas. Thus there is a fresh disposition of land masses and seas; the new folded regions and the uplifted blocks of the old continents are subjected in their turn to erosion, and continue to yield material for new series of sedimentary rocks, until they are again worn down almost to a plain.

In the regions of folding, and along the lines of fracture, the magma underlying the crust forces its way to the surface. Sometimes there is a quiet outpouring of liquid lava, sometimes the molten rock gathers near the surface and finally bursts forth with explosive violence, so that ashes and fragments of rock are thrown into the air. By a series of such eruptions cones are gradually built up, layer by layer, and are known as volcanoes (see Fig. 30). In places the magma does not reach the surface, but presses its

way up fissures or between layers of sediment where it cools and forms what are called intrusive dykes and sills. These cooled magmas form a third series of rocks, differing from the sedimentary and metamorphic; they are termed igneous. Examples of such rocks are basalts, traps and dolerites. Granite has long been held to be formed of magma which has slowly cooled at a considerable distance below the surface, and therefore is classed as an igneous rock, but it may also be formed by the same process as metamorphic rocks. The heat derived from the intrusive molten magmas sometimes causes the metamorphism of the adjacent rocks.

The Rock Series.—Again and again during the Earth's history portions of the surface have experienced periods of sedimentation followed by periods of intense disturbance—folding, fracture, or eruption—hence the present continents have a very complex structure and history. The remains of plants and animals (fossils) preserved in sedimentary rocks afford evidence of the period and order of their deposition. Thus a classification of the rocks of the Earth's crust according to age is in general use, and is given here for purposes of reference.

Quaternary	Recent. Pleistocene.
Tertiary or Cainozoic .	Pliocene. Miocene. Oligocene. Eocene.
Secondary or Mesozoic .	Cretaceous. Jurassic. Lias. Trias.
Primary or Palaeozoic	Permian. Carboniferous. Devonian. Silurian. Cambrian.
Pre-Cambrian or Agnotozoic	Algonkian. Archaean.

The term Agnotozoic (unknown life) is used for the most remote era because, although traces of organic matter have been

found in the Archaean rocks, and the remains of organisms in the Algonkian, yet no picture can be drawn of the life of this age such as can be drawn for subsequent ages. During the Palaeozoic (Old Life) Era, crustaceans of the family known as trilobites were characteristic of the oceans; vertebrates were long represented only by fishes, later on amphibians made their appearance, and at the end of the period reptiles. The vegetation consisted of cryptogamous plants (those disseminated by spores), such as giant ferns, horse-tails, and club-mosses.

During the latter part of this era there were extensive coastal lowlands, which were covered with a dense swamp vegetation, where thick beds of partially decayed vegetable matter accumulated. A slight sinking of the coast caused these plant remains to become buried under marine deposits, but as the water gradually became shallower fresh swamps appeared, and renewed sinking caused a repetition of the processes. In course of time all the deposits became compressed and hardened; the vegetable matter formed coal, which is found in thin seams separated by such sedimentary rocks as shale, limestone and sand, formed from the marine deposits. The period when coal was formed extensively is known as the Coal Age or Carboniferous Period, but it was also formed during later periods.

In the Mesozoic (Middle Life) Era, enormous reptiles were abundant both on land and in the sea, while a family of molluscs, that of the ammonites, was very widely spread. In the middle of the era flowering plants and deciduous trees appeared, as did also the first birds. In the Cainozoic (New Life) Era, mammals were very widely spread over the globe, and the abundant vegetation became more and more like that of the present day. Towards the end of this era great elephants and mastodons were especially numerous, and the man-like apes first made their appearance.

Each era represents a vast period of time. Present-day observations show how slowly sedimentation proceeds, and the processes of folding, fracturing, uplift and subsidence seem also to take place very gradually. All the estimates of the age of the Earth are in tens of millions of years.

The Modelling Processes.—Since not only crustal movements, but also denudation and sedimentation play an important part

in shaping the Earth's surface, the agencies by which these processes are carried out must be more carefully examined before land-forms can be studied.

In the modelling of the Earth's surface by external agencies, three distinct steps are observable: first the destruction or fragmentation of the solid rock, secondly the transport of the particles or fragments from their original position, and thirdly their deposit in a new position.

Weathering.—The term weathering is applied to the destruction which takes place simply through the exposure of rocks to sun and air. The heat of the sun causes rocks to expand; on cooling they again contract, and since they are not made of uniform material, stresses are set up during expansion and contraction, with the result that the rocks crack and split into large or small fragments. This action is most intense where the changes of temperature are most rapid, e.g. in deserts and on exposed mountain-sides and peaks.

Again, many rocks are porous, and others have cracks and fissures into which water can penetrate. When this water freezes it expands and breaks up the rocks, hence the action of frost is destructive.

The air contains traces of acids which act chemically upon rocks, forming with some of their constituents compounds which are friable, or readily washed out by rain. Rocks are also decomposed and disintegrated by the action of the acids formed during the decay of plants.

In all these ways rocks are broken into fragments which are then seized upon by the agents of transport. In regions where the slopes are very steep, stones and boulders may roll down into the valleys under the action of gravity, and hence masses of detritus or rock fragments accumulate at the base of cliffs and mountain-sides. These are known as talus slopes or screes.

The Work of Running Water.—An almost universal agent of transport is running water. The size of the fragments transported depends both on the volume of the water and the slope of the bed. The larger fragments, boulders, and pebbles are merely rolled along the bed in the upper and swifter courses of a river, while finer matter is carried in suspension,

though in diminishing quantities, as far as the mouth. It is evident that as soon as a river leaves its upper or torrent bed it must become an agent of sedimentation. First the boulders, then the larger stones, then the pebbles in order of their size are abandoned as the current slackens. The river is also destructive in its action ; it is an agent of erosion, using the fragments which it carries and the pebbles which it rolls along as tools with which to deepen and widen its bed. Pebbles that have been carried by rivers are characterized by the smooth rounded surface which is the result of the rolling and rubbing which they have undergone. Pure water, carrying no rock waste, has practically no erosive power. The work of transport by running water is not confined to streams and rivers. Wherever rain falls heavily on a surface which slopes even slightly, it runs down the slope bearing with it tiny particles of soil. Each rain-storm moves these particles a little farther, until at last they are washed into some stream, which bears them to a river which in turn may carry them to the sea. Thus the whole surface of the land is gradually lowered.

Underground water is an agent of destruction and also of transport. Certain rocks, chiefly those of organic origin composed mainly of carbonates, are soluble in slightly acidified water. Of these rocks, chalk is porous and can be saturated with water, while limestone is usually fissured, and water circulates through it along the fissures, gradually enlarging them, for the water contains acids derived from the air and from plants, and so acts as a solvent, carrying away particles of rock in solution. Hence the streams issuing from chalk and limestone are charged with carbonates but are very clear, carrying little matter in suspension.

The Working of Moving Ice.—The action of moving ice is very similar to that of running water. In regions lying above the snow-line the accumulated masses of snow solidify under their own pressure, and thus form ice which moves slowly down the valleys under the influence of gravity. This ice-flow is called a glacier. The rock fragments beneath the ice are dragged along, and act as tools of erosion deepening the bed of the valley. When the ice melts, these fragments form a deposit known as a ground moraine. Rock fragments detached by weathering fall down the

valley sides upon the glacier, and are borne along with it forming the side or lateral moraines. Where one glacier unites with another, the two adjoining lateral moraines unite to form a medial moraine. The deposits left at the spot where the glacier terminates form a terminal moraine. These deposits laid down by glaciers differ in some important respects from those laid down by water. They are not sorted out according to size; the largest boulders may be found side by side with the finest fragments. The pebbles instead of being rounded are angular and often scratched, as they have been dragged and not rolled along. The glacial deposits are found in irregular heaps just where they were dropped by the melting ice, instead of in the smooth layers characteristic of river sediments.

The Work of Wind.—In hot desert regions, where running water is rare and moving ice is not found, wind is a leading agent of erosion and transport. The size of the particles which the wind can carry depends upon its strength. Heavier particles are swept along the ground, and meeting with some obstacle form a little heap, which gradually increases in size until a sand-dune is formed. Smaller particles are raised into the air and when blown against the rocks help to wear them away. Fine dust-like particles are borne by the wind beyond the limits of the desert region, which is thus gradually worn down to a lower level, though at a far slower rate than when water is the agent of transport.

Wind erosion differs from river erosion in an important respect: the latter cannot continue beyond a certain limit, the former can continue indefinitely. The power of a river to act as an agent of erosion depends upon its movement; clearly, if the river wears its bed down to the level of the lake or sea into which it flows, it will no longer have any current, and hence will no longer perform the work of erosion. The term base-level is applied to the surface level of the body of water into which a river empties itself, for the river tends to wear its whole basin down to this level, but can wear it no lower. Since the winds are independent of slope and relief, the level to which a wind-eroded area can be reduced has theoretically no limit, but although the lighter particles are carried away, the heavier are drifted into the hollows, so that the ultimate effect of wind erosion is to produce a level surface.

The Work of the Sea.—Along the coast waves are agents of erosion, transport and sedimentation. The breakers as they rush forward bear the finer fragments, and roll the coarser pebbles up the beach. As they recede their power is spent, and thus the pebbles are only partially dragged back, and in course of time masses of pebbles or shingle may be piled up along the line of farthest advance of the breakers. In the same way sand is piled up, and may afterwards be driven inshore by the wind. When the waves beat against a cliff of very soft material the mere impact of the water may wash fragments away

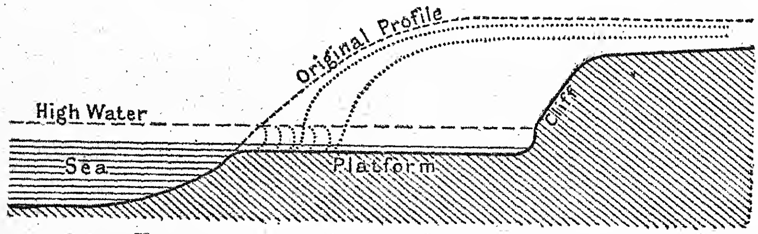


FIG. 31.—Formation of Cliff and Marine Platform.

and undercut the cliff so that landslips take place. In the case of hard rocks, the small pebbles and rock fragments dashed against the cliff by the waves perform the work of under-cutting. In the case of limestones, solution takes place and often caves are formed. Everywhere the natural weathering of the cliff face under the influence of atmospheric agencies adds to the accumulated fragments upon the beach, and these fragments are gradually worn down to finer and finer particles as they are tossed and dragged to and fro by the waves. Fig. 31 shows how, as the cliffs retreat, a flat platform covered at high tide is formed at their base.

The complicated tidal currents (see Fig. 94) of the shallow seas are active agents of transport and sedimentation. The flood and ebb currents are not usually of equal strength, for one may be reinforced by the prevailing wind or by the general oceanic circulation, while the other is retarded by the same agency; thus there is a constant drift of sand and shingle along the beach in the direction of the dominant current. Wherever the rate of a current is checked, sedimentation takes place and sand-bars,

shoals and shingle spits are built up. The property possessed by sea-water of causing a rapid precipitation of matter held in suspension leads to great sedimentation at the mouths of rivers, so that estuaries tend to be blocked by sand-bars, behind which there are quiet pools which in turn gradually fill with sediment and are transformed into deltas.

The formation of a delta in a lake is due to the sudden check given to the velocity of the river as it enters the lake, in which there is no perceptible current. Rock waste cannot be held in suspension by still water, so that in the course of time a lake becomes filled up with sediment.

Factors Modifying the Modelling Processes.—The nature of the agent of destruction and the physical qualities of the rock alike affect the resulting outline of the weathered surface. Where fragmentation by frost or by rapid temperature changes is very intense, sharp needle-like peaks, abrupt angles and steep cliff-like slopes are found. On the other hand, smooth outlines and gentle slopes are produced by running water, which rubs away the surface more rapidly where the slope is steep, and so tends to do away with steep slopes first of all.

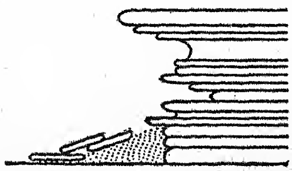


FIG. 32.—Wind-worn Rocks.

Here the degree of hardness of the rocks also comes in. The softer rocks are more easily worn down, so that sands and clays show gentle slopes almost as soon as erosion begins, while sandstones and crystalline rocks are still showing sharp angles and cliff-like faces. In the case of porous and fissured rocks, where there is little run off of water from the surface the surface erosion is slight, and steep faces may be preserved. In a region of wind erosion also, where a horizontal blast of sand is blown against the rock faces, vertical or even overhanging cliffs are found (see Fig. 32). Many rocks are fissured in a very regular fashion, both vertically and horizontally; they are then said to be jointed and bedded. Such rocks, e.g. certain limestones and sandstones, tend to break up in blocks, and as the edges of the blocks are vertical, steep faces are preserved.

The various agents which are modelling different parts of the

Earth's crust have not been constant throughout geological time. Gradual climatic changes have taken place, so that with a decrease in the rainfall, areas of rain and stream erosion have become subject to desert conditions, and vice versâ; moreover, glaciers and ice-sheets have in a cold period covered great areas, and in a succeeding warmer period have disappeared from those regions. Earth movements too have produced changes: in one place a cliff and beach sculptured by the waves is lifted high above sea-level, in another a coastal belt with its hills and valleys is partially submerged. Hence the complete description and explanation of any landscape require a knowledge of its physical history from its first appearance down to the present day.

The Ice Age.—The most important, because the most recent, great climatic change was that of the cold period known as the Ice Age, which for reasons still obscure occurred at the beginning of the Pleistocene Period. The existing mountain glaciers were enormously extended, and vast ice-sheets, comparable with those now covering Greenland and Antarctica, spread over Northern Europe and Canada (see Fig. 33). On the higher ground where the snow gathered, and from which the sheets of ice spread, the rocks were scratched and scraped bare of soil. On the lowlands, a great ground moraine was formed underneath the ice, and this was left as an irregular deposit—from 200 to only a few feet thick—when the ice melted. During this Ice Age there occurred several glacial periods marked by extension of the ice-sheets, separated by several interglacial periods marked by the partial disappearance of the ice. The torrents of water formed as these masses of ice, sometimes thousands of feet thick, were melted, played their part in modelling the surface, and many of the glacial deposits were carried away and spread out by the waters. This combined work of river-water and ice is called fluvio-glacial erosion. The glacial periods seem to have been marked by heavy precipitation, and outside the colder areas over which this took the form of snow, the existing rivers and lakes were greatly swollen. Regions now rainless were then well watered. The map (Fig. 33) shows, for example, the vast lake in the Great Basin of N. America, and the rivers and lakes of the Sahara.

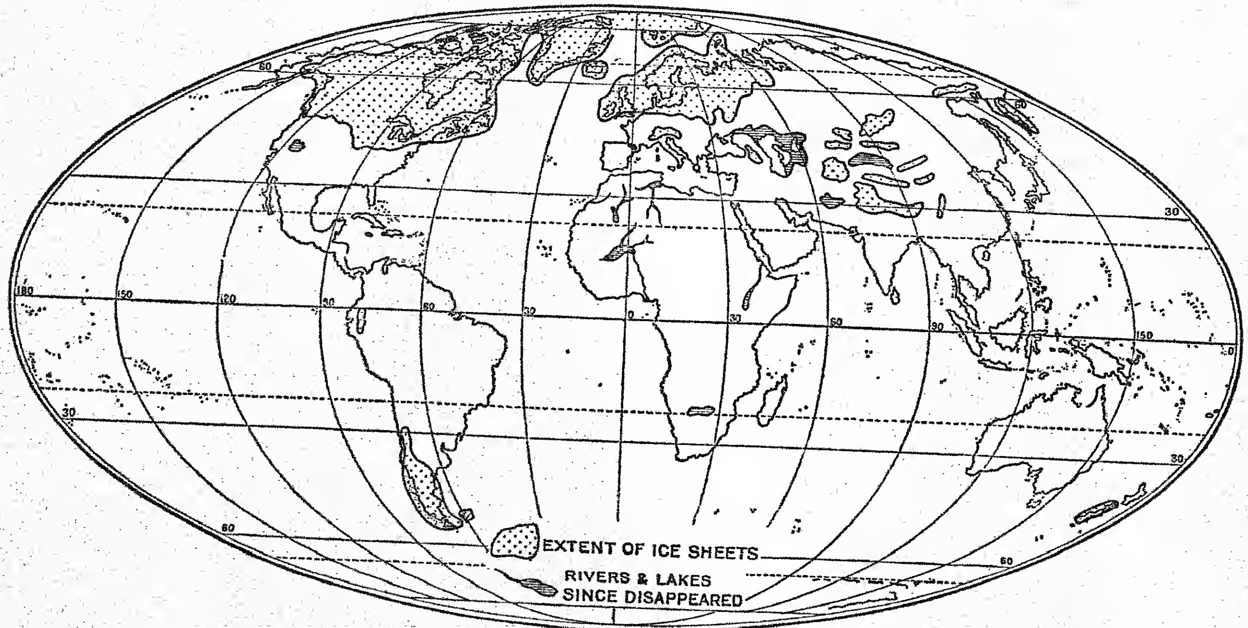


FIG. 33.—The Glaciated Areas during the Ice Age.
(*After de Martonne and others.*)

CHAPTER V

LAND FORMS

The surface features of the Earth are due in part to movements of great masses of the Earth's crust, and in part to the agents of erosion and accumulation. Where the former factor is the predominant one, the resultant forms of the relief may be termed "structural" forms, and where the latter factors have played the greater part in the modelling, "sculptured" forms such as gorges, or "accumulated" forms such as deltas may result. In practically all cases, however, the existing land forms are complex, being due to the combined effects of crustal movements, erosion and accumulation upon the same portion of the Earth's surface.

The broader divisions of the land masses into mountains, basins, plateaus, tablelands and plains are roughly coincident with structural divisions, which may therefore be briefly considered first.

Structural Forms.—Undisturbed sediments lying in horizontal strata, just as they were deposited in some sea or lake

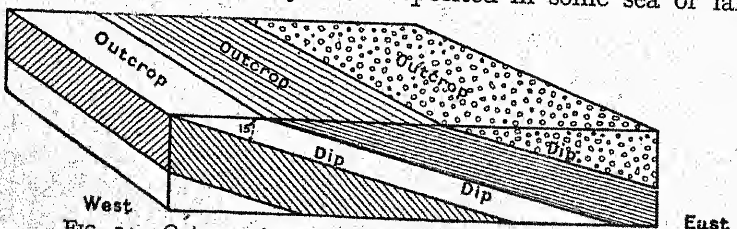


FIG. 34.—Outcrop of three Strata with a dip of 15° to the east.

bottom, give rise, when exposed, to a surface of low relief or plain. So, too, do strata which are only gently inclined. The term dip is applied to the angle of inclination of strata to the

horizontal, and the appearance of a particular rock at the surface is called its outcrop (see Fig. 34).

A large mass of horizontal sediments lifted high above sea-level will form a table-land, a surface of low relief bordered

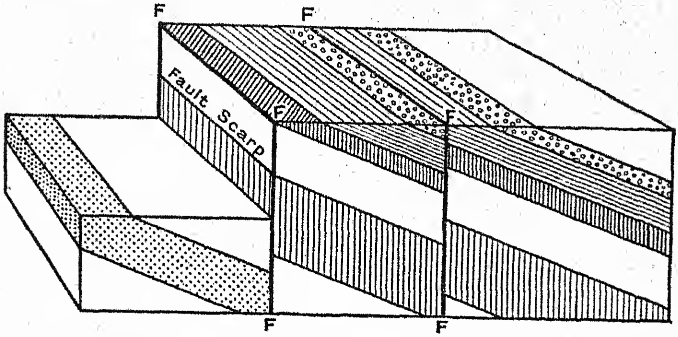


FIG. 35.—Tilted Strata, showing Faults F F.

by abrupt cliff-like edges (scarps) due to fracture and erosion, e.g. South Africa. The term fault is used for a fracture along which vertical movement (either an upthrow or a downthrow) has taken place. A fault is readily observed in a section (see Fig. 35), for the strata no longer match; at the surface it may also be detected, if it alters the series of outcrops, as in Fig. 35, where two outcrops are repeated.

An area of subsidence due to faulting may form a basin, or if the subsidence takes place between parallel faults a trough or rift, e.g. the central lowland of Scotland. Elevated masses bordered by faults form block mountains (see Fig. 36). The plane of faulting may not be quite vertical, and so tilted block mountains, with one steep scarp face and one gentle slope are formed, together with unsymmetrical basins, e.g. the Khingan Mountains in Eastern Asia and the coast range parallel to them (see Fig. 37). A simple upfold, or anticline (see Fig. 29) will form if very broad a level upland or plateau, if narrow, a range of hills or

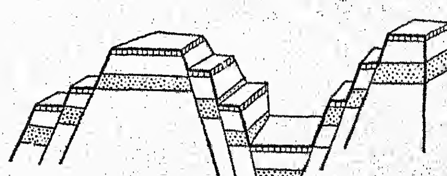


FIG. 36.—Diagram of Block Mountains and Rift Valley (*after de Martonne*).

mountains, e.g. the Pennines. A simple downfold or syncline will form a basin, e.g. the London Basin, or if very narrow a valley. A series of upfolds and downfolds will form a folded mountain system consisting of roughly parallel ridges and valleys; the Jura Mountains form the best example, but such a simple structure is uncommon. The great mountain systems, such as the Alps, are usually due to the combined effects of folding, over-folding, fracture and over-thrust, followed by the uplift *en masse* of parts of the disturbed area, and the depression of other parts.

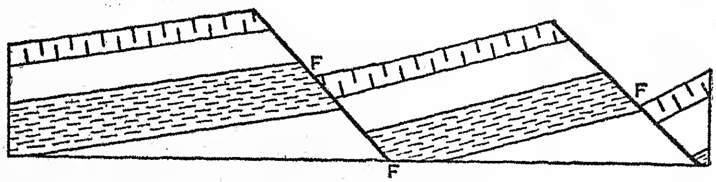


FIG. 37.—Diagrammatic Section of Tilted Blocks and Basins.

Volcanic Forms.—The building up of volcanic cones by successive outbursts of lava and ashes has already been mentioned. Lava is a viscous fluid which may flow some miles before cooling and hardening. Sometimes it issues from vast fissures and spreads over a wide tract of country, obliterating the relief and forming a level plateau. Basalt is one of the commonest materials of which such plateaus are formed, e.g. the plateau of Antrim. The volcanic cone itself may be destroyed by weathering, and the hardened lava which filled the central vent may be left standing as a rocky crag, known as a volcanic neck. In the same way the lava which filled a vertical fissure in a bed of sedimentary rocks may remain as a narrow wall-like ridge (a dyke), after the softer sediments have disappeared. An intrusive sheet or sill of lava often acts as a protecting cap to softer rocks and leads to the formation of a ridge or a table mountain, owing to differential erosion, i.e. erosion which has proceeded at unequal rates.

Wells and Springs.—When rain falls upon the earth, part of the water remains in pools upon the surface to be quickly re-evaporated, part is absorbed by the soil to be used by plants or

slowly evaporated, but the disposition of the remainder varies, according as the rock underlying the soil is permeable (porous or fissured), or impermeable. In the former case the water sinks into the ground, in the latter it runs off the surface, following the lines of steepest slope, the drops uniting in tiny rills which find their way to a neighbouring stream. Since the water can only sink into the ground gradually, a very heavy rain will cause a surface run-off even from permeable rocks. A bed of permeable rocks often rests upon an impermeable layer, which will prevent the water sinking further; the upper beds thus become " water-

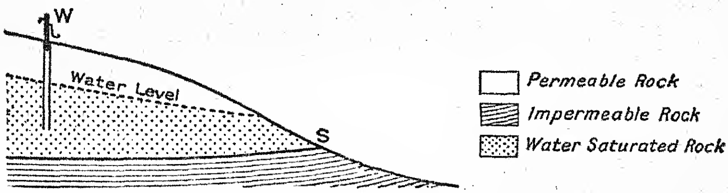


FIG. 38.—Well and Surface Spring.

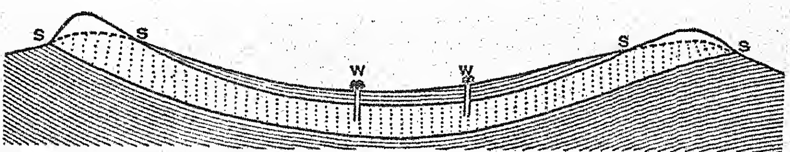


FIG. 39.—Artesian Wells and Springs.

bearing," being saturated up to a certain level with the accumulated water, which may be obtained by wells sunk to the " water-level." The water cannot, however, accumulate indefinitely, and may gush out under the form of springs. Fig. 38 shows a well (*W*) from which water can be pumped up, and a surface spring (*S*). Fig. 39 shows a downfold where a permeable bed is situated between two impermeable beds. The rain falling on the outcrops of the former will saturate it with water, which will gush out from the springs *S*, *S*, or from the wells *W*, *W*. In the case of these wells the water will be forced out by what is known as hydrostatic pressure, that is, the pressure originating in the weight of the water standing at a higher level in the neighbouring regions, and transmitted throughout the whole water-mass.

River Forms.—Innumerable springs and surface rills combine to form a river, which follows the line of steepest slope down to the sea. When a surface is newly formed, or newly upraised from the sea-floor, its first river system is entirely dependent upon the original slopes and inequalities of the land; but changes soon take place. Each stream is at work, deepening and widening its valley, but all do not work at the same rate. A heavier rainfall on its basin, a softer rock to work upon, a swifter current due to a short steep slope to the sea, any or all of these may give one stream an advantage over its neighbours, and lead to its encroaching on their basins and capturing some of their waters.

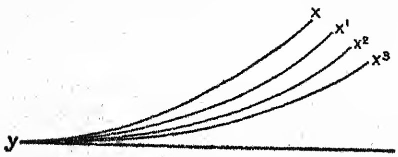


FIG. 40*a*.—Lengthening of a Valley.

The valleys of the more energetic streams are lengthened at the expense of others by reason of the wearing of the ground as indicated in Fig. 40*a*, which shows a longitudinal section of a valley and the successive positions it occupies as the water flows down the slope; the head of the stream is found successively at the points x, x^1, x^2, and x^3, and its length increases from xy to x^3y. Fig. 40*b* shows a section of a mass of land and the changes of the slopes DA and DB of valleys cut by rivers

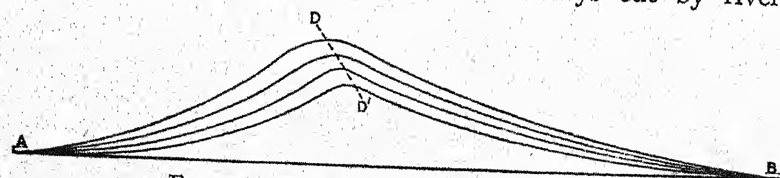


FIG. 40*b*.—Lowering and Shifting of a Divide.

flowing to A and B respectively. If the river flowing to A cuts downward and backward at a greater rate than that flowing to B, the divide which was first at D will be lowered and will shift back to D^1. Figs. 41*a* and *b* show a map of two streams, one of which (A) has enlarged its drainage area at the expense of the other (B), by wearing back the divide, and capturing the headstreams of (B).

As a result of such changes numerous small river basins

are replaced by a few large ones, drained by great rivers fed by numerous branching tributaries and sub-tributaries. These large rivers are well adjusted to the structure of the rocks, the streams on the less resistant outcrops having developed at the expense of those on the more resistant. Many evidences of capture may be observed in countries that have a matured drainage system, for example, some of the streams are too small

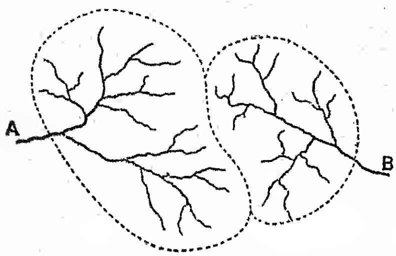


FIG. 41*a*.—Original Drainage Areas of streams **A** and **B**.

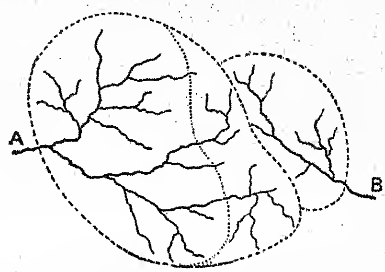


FIG. 41*b*.—Drainage Areas of streams **A** and **B** after shifting of Divide.

for their valleys, having been robbed of their head-waters, or there may be dry valleys from which the waters have been diverted altogether.

This process is not the only one which results in dry valleys, for in areas where there are great outcrops of permeable rocks, there may be a gradual subsidence of the surface where under-

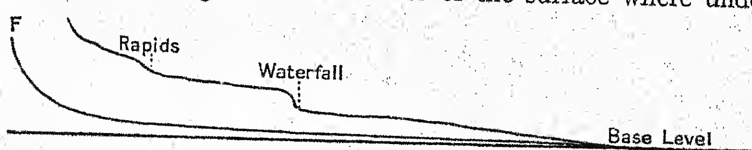


FIG. 42.—Initial and Final Profiles of a River.

ground streams remove material from below, so that the surface is gradually lowered into the form of a valley although no stream is visible. The chalk hills of south-eastern England afford examples of both types of dry valley.

The work of a river in (*a*) deepening and (*b*) widening its valley has been referred to. Assuming that the surface is uniformly resistant, the deepening takes place most rapidly where the current is swiftest, i.e. where the slope of the bed is

steepest; hence a river tends to wear its bed to a uniform slope, for where there is any sudden change of slope, such as causes a rapid or waterfall, there the erosion is most vigorous. A section showing the slope of a river-bed from source to mouth is called a profile. Fig. 42 shows the initial irregular profile of a river, and the final smoothed one (F). The extreme upper part of the bed is not worn down to the base level (see p. 53) because, although the streams there are rapid, their volume is small. A river system in a recently folded or fractured region where there are steep slopes and abrupt cliff-like rock-faces will naturally have many rapids and falls. So, too, will a system draining a land which has been covered by an ice-sheet, and is strewn with the great irregular deposits of rock waste once carried by the ice-sheet (see p. 56). Many rapids and waterfalls are however due, not to any original irregularity in the land surface, but to the unequal power of resistance in successive rocks traversed by the river, which therefore cuts portions of its bed more rapidly than others.

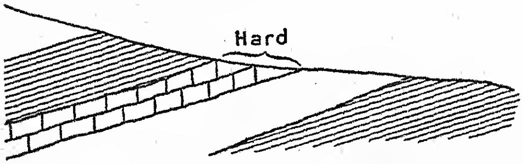


FIG. 43*a*.—River Profile, showing Hard Outcrop.

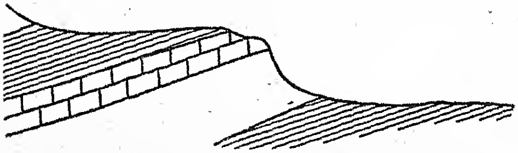


FIG. 43*b*.—River Profile at a later stage, showing Fall due to Hard Outcrop.

Figs. 43*a* and *b* show such a case where a hard outcrop causes a waterfall.

The widening of a valley is performed partly by the river itself, partly by other agencies. The action of the latter is very simple, and will be explained first. Fig. 44 shows a valley section, due simply to stream erosion. The steep sides are exposed to wind and air, to frost and heat, so

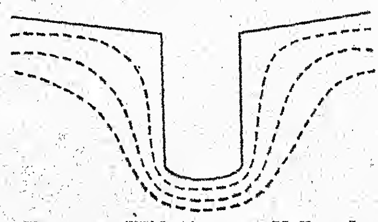


FIG. 44.—Widening of a Valley, I.

that the surface is gradually broken up and fragments fall into the stream bed and are borne away. The surface water running down the valley sides towards the stream also carries with it particles of soil, so that in course of time the valley acquires the section shown by the dotted lines.

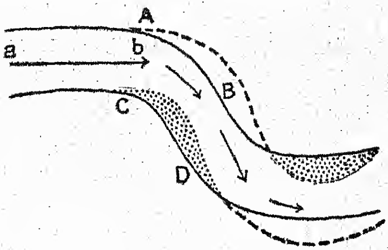


FIG. 45.—Widening of a Valley, II.

The process of widening carried out by the river itself is more complex. No stream is quite straight for more than a very short distance, and whenever it curves the result is to produce strong currents, first under one bank, then under the other. Fig. 45 shows such a curve. The natural direction of the current is *ab*, i.e. towards the valley side *AB*, and therefore the water presses against this side of the valley and constantly undercuts it. Near the opposite bank *CD* the water is almost slack, so that here the stream leaves the gravel it is rolling along, and drops the fine waste it is carrying in suspension. Fig. 46 shows in the foreground a section of the valley. As the under-cutting proceeds, the rock masses above repeatedly collapse, so that fresh faces are exposed to the weather; thus one side of the valley remains steep, while the opposite side is weathered to a gentle slope. At the foot of this gentle slope is a bed of gravel and alluvium which is gradually abandoned by the river and becomes firm ground. In this way the valley acquires a wide level floor, and in a view up or down stream the long gentle slopes, first on one side, then on the other, appear as a series of interlocking spurs (see Fig. 46). If this process continues uniformly, the windings tend to increase, and the area of attack is pushed farther and farther down stream, as shown in Fig. 47. In course of time the projecting spurs are in their turn worn

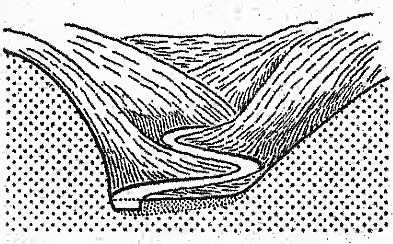


FIG. 46.—Widening of a Valley, III.

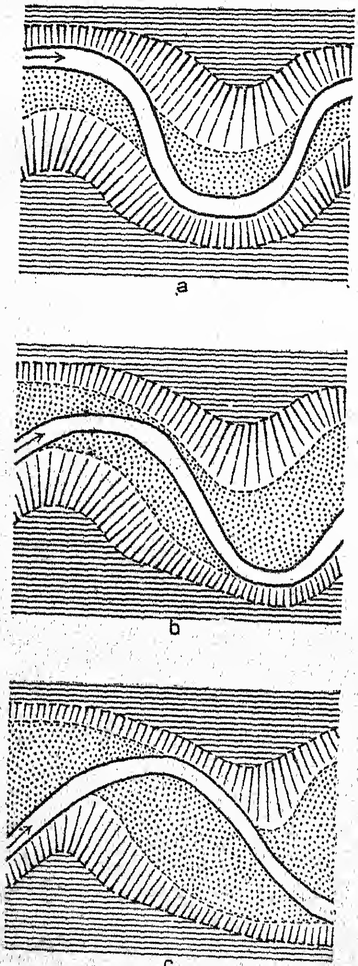


FIG. 47.—Plans of a part of a river's course, showing the shifting of the river bed, the formation of a flood-plain, and the cutting back of the sides of the valley.

away, so that the river meanders in a flat-bottomed valley bordered by low parallel bluffs. After heavy rains the river may overflow its banks and partly or wholly fill the valley, which is termed its flood-plain. The flood waters, having no current, drop the waste they hold in suspension, so that the flood-plain is gradually covered by alluvial deposits.

As in the case of deepening, the widening will take place at unequal rates in rocks of unequal resistance, so that in one place a valley may be widely opened, while lower down the river it may still be narrow and steep-sided. The terms young, mature and old have been applied to the stages in the development of rivers and their valleys according as they are just beginning, are well advanced in, or have almost completed the processes described above. Thus a river in the youthful stage has a narrow gorge-like valley, its profile is probably broken by rapids and waterfalls, the processes of erosion and transport are going on rapidly, and there is little sedimentation. A river which has attained maturity has widened its valley floor, and has formed a system of interlocking spurs; the processes of widening, deepening, erosion, transport, and sedimentation are all going on. The

effect of unequal rock resistance may be manifest in rapids or falls, or in the alternation of narrow and wide valleys. When old age is reached, a river has a regular profile and a broad flood-plain; it has almost ceased the work of erosion and transport, the more active process being that of sedimentation. The effect of this is slowly to raise the level of the bed, the banks and the flood-plain beyond them, so that an old river may flow at a level above that of the surrounding country, being kept in its course by the natural banks or levees formed of material deposited by flooding. Such a river may burst the levees and cause very disastrous floods.

The relation of tributaries to the main river also changes with advancing age. The level of the river at the point of junction forms for each tributary the base-level to which it tends to adjust its profile. In a region still young, or in early maturity, the more powerful main stream may have a flat-bottomed valley, but it may still have steep sides, down which veritable torrents flow. These will have their velocity suddenly checked by the abrupt change of slope, and will therefore deposit masses of rock waste on the valley floor. These deposits are called alluvial fans, or cones, on account of their shape. In other cases waterfalls or rapids may mark the entrance of tributary streams, but by the time old age is reached the beds of all the tributaries have been smoothed down until their profiles are in exact accord with that of the main stream.

The passage from youth to maturity and thence to old age, is not dependent upon time alone. As implied above, the characters of youth are long retained by rivers which flow over specially resistant rocks. In arid regions, too, where there is little surface water to help the widening process, the valleys are deep and gorge-like. Limestone regions are similar to arid ones in this respect, for they have little or no surface run-off and consequently the valleys are steep-sided.

Since the volume of water in a river usually increases towards its mouth, its working power will increase in this direction also. Hence many rivers show signs of old age in their lower courses, while in their middle courses they are mature, and in their upper courses still youthful.

A region traversed by old rivers has had nearly all inequalities of relief swept away, and is termed a peneplain. It must often happen that rivers which have nearly completed their cycle of erosion are forced to recommence active work owing to some earth movement, for example the uplift of the upper portion of their basins or the subsidence of the region into which they flow, which may alter their relation to their base-level, and so restore swiftness to their currents. Very frequently the peneplain, by uplift, becomes a plateau, which is gradually dissected by the rivers as they move in a fresh cycle from youth to old age.

Lakes.—Streams or rivers which enter a lake work down to its level as their base. Lakes may occur in any hollow on the Earth's surface. Such hollows may be due to the subsidence of part of the crust along lines of fracture (basins or rifts), they may be due to downfolding, they may be craters of extinct volcanoes, or in a limestone country they may be due to surface solution or to the subsidence of the roof of some underground cavern. Lakes may also be formed in valleys whose natural outlet has been barred, as for example by a lava-flow or by an old glacial moraine; also it sometimes happens that a side valley is dammed by a glacier which fills the main valley. In the regions once extensively glaciated, lakes may abound in hollows scooped out by the ice-sheet, as in Finland, and the long, narrow, deep lakes which occur in valleys once occupied by glaciers may be numerous, as in Scotland. As a general rule the water entering a lake exceeds that lost by evaporation, so that there is an outflowing stream, but in regions of low rainfall and great evaporation this is not the case, and the hollow containing the lake has no outlet. In such a case the basin forms an inland drainage area. All the salts brought down in solution by the rivers accumulate in such lakes as these, which therefore have a very high salinity. Where the rainfall is very irregular, they are liable to great fluctuations in level and area, and in time of drought often dry up entirely, leaving only a salt-encrusted mud flat.

Lakes through which rivers flow are comparatively short-lived, for all the streams that enter them deposit in their still waters the rock-waste which they hold in suspension. Thus deltas are built up and each lake is gradually transformed into

an alluvial lake-plain. Also the outgoing stream in time cuts a deeper channel, facilitating the drainage of the lake.

Lakes are of great importance in regulating the flow of rivers. Heavy rains may convert their head-streams into swollen torrents, whose waters, if poured directly into the main valley, would cause disastrous floods, but spread out over the wide surface of the lake they cause only a slight change of level, so that the river below the lake suffers but little change.

Plains and Plateaus.—Some important types of plains have already been mentioned in the above account of the work of

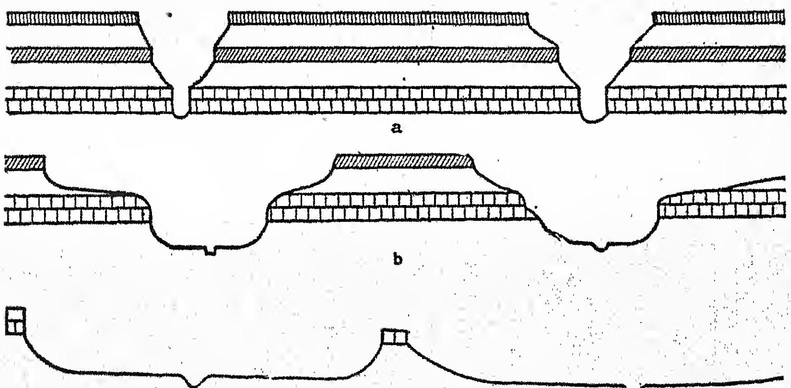


FIG. 48.—Dissection of Plateau of Horizontal Strata.

rivers, among them the flood-plain, the peneplain, and the lake-plain. To these may be added the recently uplifted sea-bottom which forms a coastal plain. Such a plain, owing to the absence of steep slopes, will have a very indeterminate drainage system, swamps and lakes will form in slight hollows, while the river valleys will be shallow, the divides low and ill-marked.

A plateau formed of horizontal strata will, when young, be intersected by deep cañons, and if the rocks are of unequal resistance these will have the characteristic section shown in Fig. 48 *a*. At a later stage the valley floors widen and the plateau is broken up into large table-topped mountains or mesas, while still later, the greater part of the surface becomes a plain, dotted

over with a few relics of the plateau in the shape of buttes or kopjes (see Fig. 48 *b* and *c*).

A plateau bordered by steep cliff-like faces or scarps may be termed a tableland, and if it is built of nearly horizontal strata, the edges will in course of time be worn to a series of scarps separated by broad terraces, similar to a side of the left-hand valley shown in Fig. 48 *b*.

Ridges and Gaps.—If beds of sediments of unequal resistance are gently inclined, the weaker rocks are worn to plains, separated by hilly belts formed of the more resistant rocks. Two such

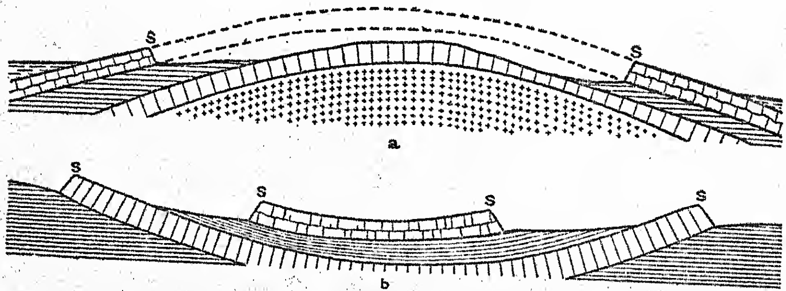


FIG. 49.—Scarped Ridges (ss) developed from Folded Strata of unequal resistance.

formations are shown in Fig. 49 *a* and *b*, the one due to an upfold, the other to a downfold. The hills have on the one hand a steep face or escarpment, on the other a long gentle slope following the dip of the strata; they are known as scarped ridges. If the dip slope is very steep the ridge is narrow, its section having the form of an inverted V. Such a ridge is known as a hog's back; a good example is found in the portion of the North Downs west of Guildford.

Fig. 50 shows the development of the river system in a region where the gently inclined strata form a coastal plain. In diagram *a* the rivers flow down the dip slope to the sea; in diagram *b* the differing resistance of the rocks over which they flow is manifest. The weaker strata form plains on which lateral tributaries develop, the harder strata form scarped ridges across which the rivers cut deep and narrow valleys; these are known as water-gaps. On the bands of weak rock the divides

between the different river systems are ill-marked, so that it is here that captures take place. In diagram *c* a map of such a

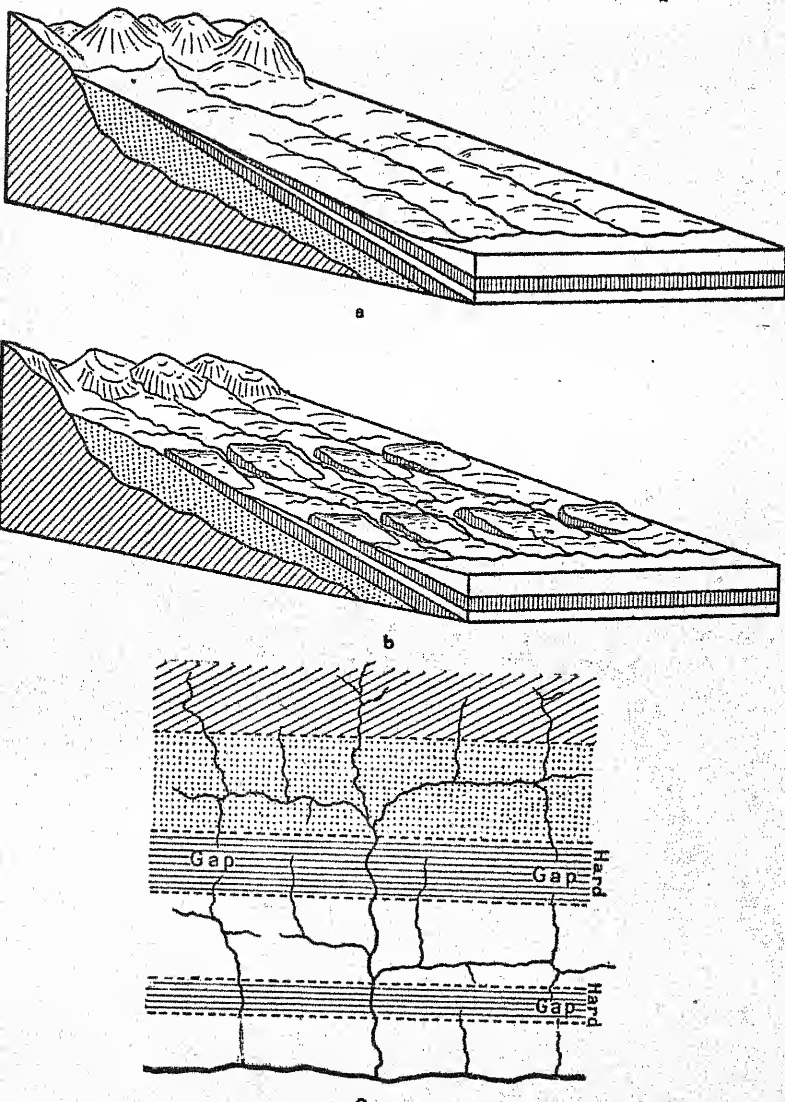


FIG. 50.—Development of River System on Inclined Strata of unequal resistance.

drainage system is shown. Only one river has maintained its difficult course across the two hard ridges, and this river has long important tributaries flowing along the weak outcrops, while smaller tributaries flow down the dip slopes. Three gaps are left through which streams no longer flow; since only wind now passes through these, they have been termed "wind-gaps." Wherever a river is seen to pierce a hill or mountain ridge instead of flowing round it, it may be inferred that the river is older than the ridge, and that the latter has either been carved out by the river itself, as in the case described above, or is due to some recent uplift or other crustal disturbance.

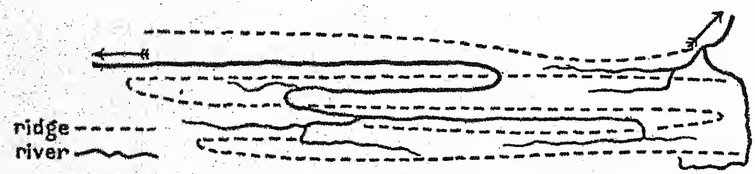


FIG. 51.—River System in Region of Parallel Ridges.

Fig. 51 shows the river system in a simple folded mountain chain. Here the rivers appear to cut across the ridges transversely as they pass from one downfolded valley to the next. The explanation of these transverse valleys is to be found in the original form of the land surface. It has been proved that intense folding only takes place at very great depths, where the rocks are plastic, and that at the surface itself the initial deformation is very slight. Fig. 52 shows a block section and sketch of a folded region; the violent contortions of the buried strata produce at the surface two slight ridges AB, $A'B'$, and a shallow valley SS'. The upfolded ridge in the foreground is not uniform, its longitudinal section shows a slight downfold at D, while the downfolded valley SS' shows a slight upfold at C. The waters to the right of C escape from the valley at D. Diagram b shows the relief at a much later stage, when the violently disturbed strata have been exposed by denudation. The upfolded ridges stand out in bold relief, but the river has maintained its course at D, and has cut a deep notch-like valley or water-gap in the foremost ridge. In all the great moun-

tain regions the relief is mainly due to erosion, and the river systems have been determined by the original slight inequalities of the surface, but are modified by the captures which take place as they adjust themselves to the irregularities of the rocks which they lay bare. It seems probable that the whole folded mass is gradually uplifted as well as denuded, and that the contorted strata now exposed on many mountain-sides were

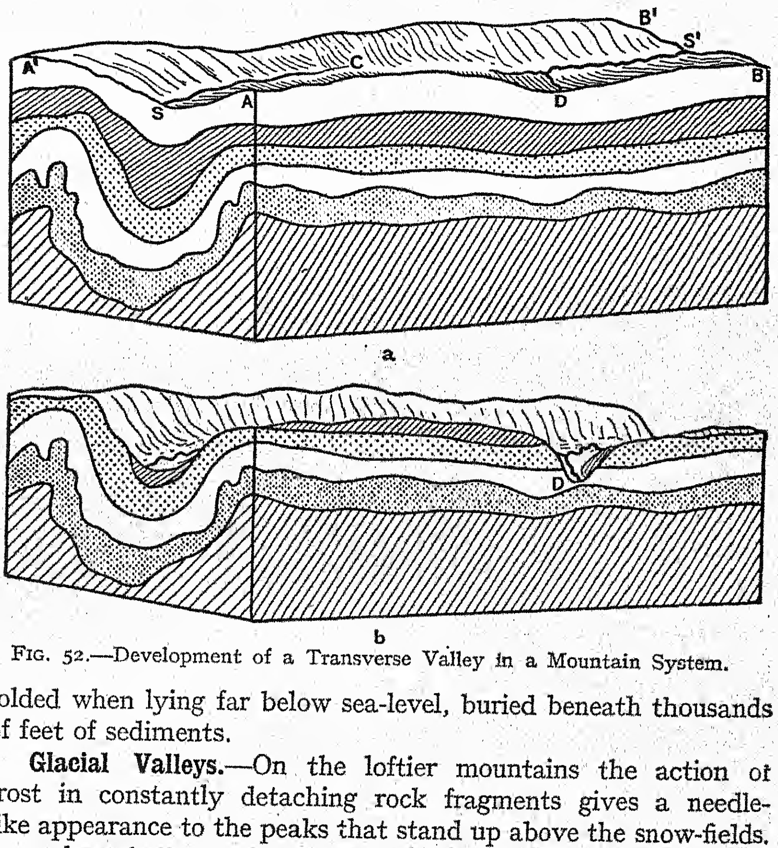


FIG. 52.—Development of a Transverse Valley in a Mountain System.

folded when lying far below sea-level, buried beneath thousands of feet of sediments.

Glacial Valleys.—On the loftier mountains the action of frost in constantly detaching rock fragments gives a needle-like appearance to the peaks that stand up above the snow-fields. In such regions, too, the valleys are largely shaped by glaciers. The ice scoops out for itself a trough-shaped bed, while above the level of the ice-surface the ordinary agencies of modelling are widening the valley. The resulting profile can be seen in valleys

from which the glaciers have disappeared since the Ice Age; it is shown in Fig. 53. The abrupt change of slope at the point A is often the cause of beautiful waterfalls where side streams enter the valley.

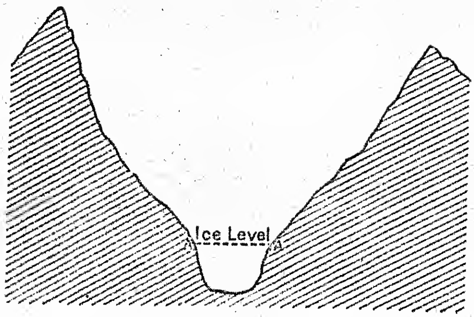


FIG. 53.—Section of Glacier-Deepened Valley.

Dissected Plateaus.—An old folded region which has been worn to a peneplain may be uplifted to form a plateau or a block mountain. The work of erosion then recommences, and a fresh system of hills and valleys is carved out. If the surface of the peneplain shows regular outcrops of hard and soft rocks, the remains of some past system of regular folds, then a series of parallel ridges and valleys will result. If the outcrops are irregular, then the general tilt of the surface and the form of the river network which crosses it will determine the distribution of ridges and irregular massifs into which the area is gradually divided. In any case, the flat level tops of the mountains and ridges as seen against the skyline will show that they form part of a once continuous surface. A river which meandered in a flat-bottomed valley across the old peneplain will often keep pace with the uplift by deepening its bed, so that the meanders are incised into the plateau. The name dissected plateau has been given to such an uplifted and re-eroded land mass.

Desert Forms.—In a region where, owing to the low rainfall, running water takes little part in the work of modelling the surface, special land forms are found. Mountains are half buried under their own waste, rocks are split into great boulders by the rapid heating and cooling that they undergo, some areas are swept bare of soil by the wind, and in others the sand is piled up in shifting dunes. The faces of the hills are polished and eroded by the sand blast, and where the rocks lie horizontally and are unequally resistant a profile such as is shown in Fig. 32 results. The rain-water of occasional storms sweeps out small

gullies, whose boulder-strewn beds are usually dry, but on the whole there is a great monotony in the landscape.

Coast Forms.—The action of the sea in shaping the coasts has already been touched upon. The waves eat back the cliffs and form a marine platform, or they pile up sand and shingle. Hard rocks may stand out as headlands while weaker rocks form bays, but in course of time such a coast will be worn smooth again, as the headlands will form special points of attack while the quiet bays will receive deposits of the material thus worn away. Rivers build out the coast seawards, extending their flood-plains in the form of deltas, in the manner described in the previous chapter. The accumulations of alluvium block up the river channel, with the result that it is forced to find new outlets, and enters the sea by two or sometimes more channels. If, however, the tidal or ocean currents are sufficiently strong to sweep away the river alluvium, no delta can be formed. Only the very largest rivers can bring down sufficient alluvium to maintain a delta on the ocean margin, and hence they are more usually found in the tideless enclosed seas.

In many places the outline of the coast is due to a change in the sea-level or to a subsidence whereby the land is partially submerged. Thus the sea water overflows the lower grounds, transforming river valleys into straits or estuaries and broader lowlands into bays, while hills and mountains remain as promontories or islands. It is in this way that the irregularities of the western coasts of the British Isles have been produced. Where the land has been deeply dissected by erosion, there the "half drowned" coast is very irregular, and where the land has been worn to a plain crossed by broad open valleys, there the coast is low and smooth, broken only by shallow estuaries. The east coast of England affords an example.

The drowning of a region of ridges and furrows, where these are cut transversely by the coast, leads to the formation of long, tapering rocky promontories, separated by equally long narrow inlets, which become narrower and taper inland. Such inlets are called rias. The south-west coast of Ireland affords an example. Where the coast is parallel to the ridges, it is straight and unbroken except where the sea can find an entry

through some gap in the outermost ridge. If, however, the ridges have been very much dissected by erosion, the outer ones may form a line of long narrow islands, and the outer furrows a series of sounds. The east coast of the Adriatic Sea affords an example.

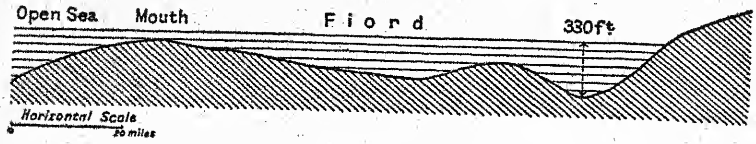


FIG. 54.—Longitudinal Section of a Fiord.

Another important type of inlet is the fiord. Fiord coasts are found on the margins of regions of high relief (dissected plateaus or fold mountains), which have once been heavily glaciated. The glaciers making their way to the sea have scooped out deep trough-like valleys, the drowned ends of which become narrow, steep-walled inlets. A fiord is usually very deep, but becomes shallower towards its mouth (see Fig. 54). This may be due to the diminishing power of erosion of the glacier as it gradually melts, or to a terminal moraine blocking the end of the drowned valley. Norway, Scotland and British Columbia have fiord coasts.

The Continental Shelf.—The actual shore-lines do not mark the true borders of the continents; the latter are usually prolonged seawards by a gently shelving platform sometimes 100 miles or more in width, which is roughly outlined by the contour or isobath of 100 fathoms; beyond this there is a sudden drop to depths of 1000 fathoms or more, so that the platform has a steep cliff-like edge. This bordering platform, covered by shallow seas, is called the continental shelf; on it the rock waste from the land gradually accumulates, and hardens into fresh sedimentary rocks.

Islands.—Islands which are merely portions of the mainland separated by the erosion, subsidence, or drowning of the intervening land are termed continental. Those which have an origin independent of the mainland are called oceanic. The latter may be volcanic, built up of lavas poured out from some vent in the sea floor, or they may be coral islands, built up by living organisms. The coral polyps can only live in the shallow waters of tropical seas. They secrete an abundance of limestone, and associated

with them live numerous shell-fish, and other limestone-secreting organisms. The polyps may build a fringing reef along the coast, or a barrier reef at the outer edge of a marine platform or continental shelf. Fragments of shells, coral and coral-sand are piled up by wind and wave on and behind the reef, so that new land is formed. Often a coral island takes the form of a circular reef partially enclosing a still lagoon. It is then called an atoll. The exact origin of atolls is still in dispute, but some, at least, have been formed on the summits of volcanoes which do not reach the surface of the ocean.

Structural Regions.—An idea of the general world-distribution of the above described land-forms can be obtained by noting the areas once glaciated (Fig. 33), where ice-modelling is important, and by observing on the map showing the total annual rainfall (Fig. 84) the areas of abundant and scanty rainfall, where rain-and-stream or wind action respectively predominate. To this must be added a study of the main structural divisions given in Figs. 55 and 56, which show the disposition of the rocks on which the modelling agencies have been or are at work. All these maps should be compared with the relief maps of the different regions, which show the surface forms resulting from the varying factors.

On Fig. 55 only the broader structural divisions are marked. Two large peneplains of very ancient rock are found, one in North America, partly drowned by the waters of Hudson Bay, and one in North-West Europe in the hollow of which lies the Gulf of Bothnia. Unfolded rocks of various ages form the vast plains stretching from north to south in the Americas and in Australia, and from east to west in Eurasia. Tablelands of undisturbed rocks, generally very old, extend through Guiana, Brazil, Africa, Arabia, the Dekkan, and Western Australia. The lofty mountain systems of the world, with the great plateaus and basins which they enclose, correspond to the regions of most recent folding. They form a girdle round the Pacific Ocean, consisting of the western Cordillera of the two Americas, and the island loops which fringe Eastern Asia and Australia. Here the general trend of the chains is from north to south. In Central America, in Eurasia and in North Africa the mountains run from east to west, until they reach Further India, where again the north to

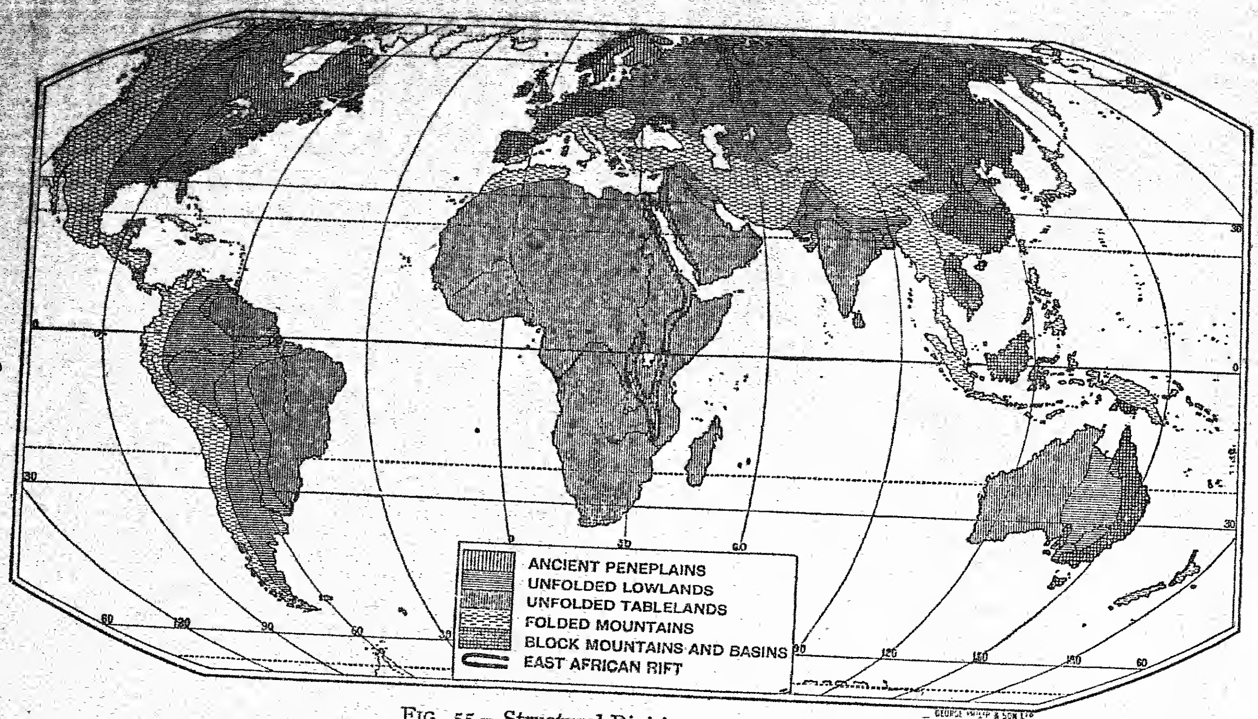


FIG. 55.—Structural Divisions of the Land.

(After A. J. Herbertson and others.)

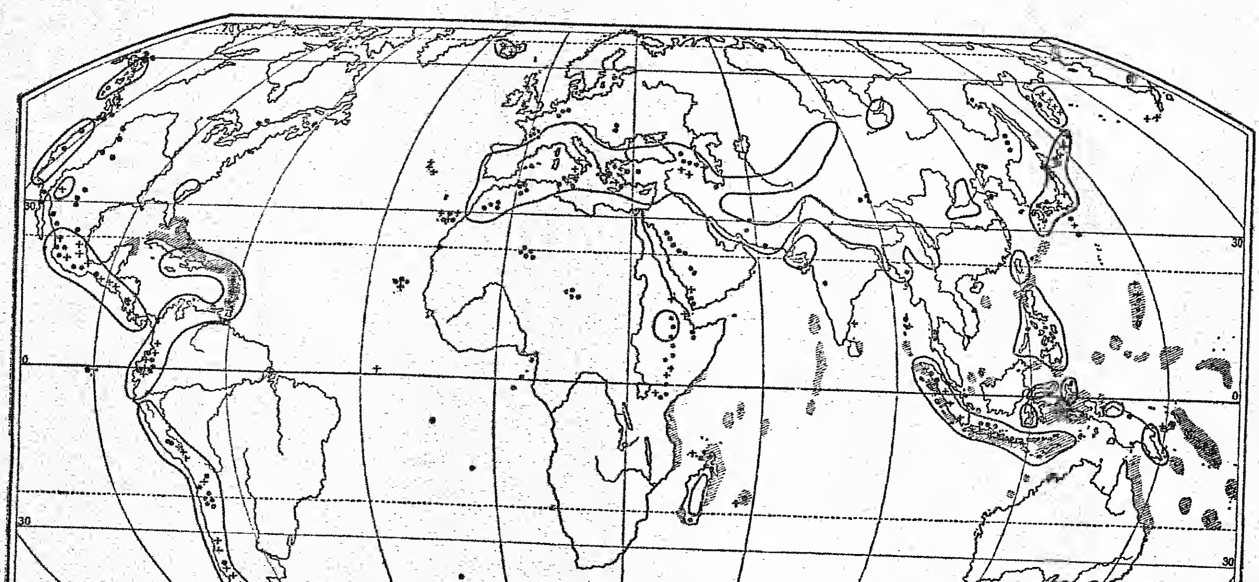


FIG. 56.—Distribution of Volcanoes, Earthquakes, and Coral Reefs

south direction is seen. Regions of block mountains, dissected plateaus and basins border the north Atlantic on either side, and extend from north to south through Eastern Asia and Australia. Fig. 56 shows the distribution of earthquakes, volcanoes and coral reefs. Active volcanoes and earthquakes may be taken as evidence of an existing weakness or instability of the Earth's crust. They occur chiefly, as might be expected, in those regions of high relief where the most recent folds and fractures are found. It should be noticed that the map does not bear out the statement that all volcanoes are near the sea.

Soils.—Owing to the gradual disintegration of the rocks, the Earth's surface is almost everywhere covered with a layer of loose waste from a few inches to many feet deep. This waste is darkened by the admixture of decayed vegetable and animal matter (humus) and forms the soil. It may be the direct product of the decay of the underlying rock, or it may have been deposited by some agent of transport. The most fertile soils are those which are of mixed composition, the products of the waste of many different kinds of rocks; such is usually the nature of the transported soils. Hence all regions of accumulation, such as valleys, basins, flood-plains, old river-beds and old lake-floors are especially fertile. The till or boulder clay which formed the ground moraine of the ice-sheet also yields a rich soil, unless too encumbered with stones and boulders, but the coarser ice and river deposits, such as gravels, are poor. Among the transported soils, loess is also important. It covers wide areas round the margins of the arid interior of Asia, and of the regions once heavily glaciated. It consists of fine particles swept by the wind from accumulations of dry rock waste, such as exist in the desert regions. During the Ice Age, the inter-glacial periods marked by a temporary retreat of the ice were very dry, and hence the vast moraines were subjected to wind erosion, and yielded material for loess deposits. Among soils of local origin, those due to the weathering of limestone (which is rarely pure) are fertile though thin, and those derived from volcanic rocks are often exceedingly fertile, while infertile sandy soils are yielded by such rocks as sandstone and granite. In those places in the temperate zone which are imperfectly drained, the vegetation does not

completely decay, but forms a dark brown, fibrous mass called peat, which absorbs water like a sponge, and renders the ground boggy. In arid regions the soils are often exceptionally rich owing, among other reasons, to the fact that their soluble salts are not washed away as in humid regions.

The Arun Gap.—Several of the land forms mentioned above are illustrated in the portion of the Ordnance Survey Map given in Fig. 2. The Arun river has cut a gap across the chalk South Downs, and has so widened its valley that the latter has a flat alluvium-covered floor over which the river meanders; the regularity of the meanders has, however, been largely interfered with by the making of artificial "cuts." At North Stoke there is a good example of the inequality of the opposite slopes of a valley; from the east a long gentle slope runs down to the alluvial plain, while on the opposite side there is a steep slope close under which the river flows. The section at this point (given in Fig. 4) may be compared with the section in the foreground of Fig. 46. An observer looking down the valley from the little hill to the south of the footpath leading from Bury to Amberley, would see a series of interlocking spurs, the best marked being the first three on which stand Houghton, North Stoke and South Stoke respectively. The chalk strata dip gently southward, and have been worn back to a scarped ridge (see p. 70) of which Rackham Hill forms part, the escarpment facing north, the dip slope facing south. The permeability of the chalk accounts for the dry valleys in the hills. It is noticeable that no villages, and very few farms are found high on these waterless hills, while on the other hand no villages are found on the perfectly level, and therefore ill-drained, valley floor, the sites most favoured being the lower slopes and spurs of the hills. The importance of this gap in former times as a route-way is suggested by the castles which guard both its northern and southern entries.

AUTHORITIES AND BOOKS FOR FURTHER READING.

J. A. Steers: *The Unstable Earth* (Methuen).
V. C. Finch and G. T. Trewartha: *Elements of Geography* (New York: McGraw-Hill).
A. E. Trueman: *The Scenery of England and Wales* (Gollancz).
E. de Martonne: *Traité de Géographie Physique* (Paris: Colin).
P. Lake: *Physical Geography* (Cambridge Press).
L. J. Wills: *Physiographical Evolution of Britain* (Arnold).
S. W. Wooldridge and R. S. Morgan: *Physical Basis of Geography* (Longmans).

CHAPTER VI

INSOLATION AND TEMPERATURE

Light and heat, which are essential to organic life, are forms of energy transmitted to the Earth from the Sun by radiation. The Sun sets up wave movements in the ether which travel with high velocity through space, reaching the Earth in about eight minutes. When some material object is struck by these waves it becomes illuminated and heated, while certain objects, e.g. a photographic plate or the green parts of plants, undergo chemical changes. When a body is heated, it may either simply undergo a change of state (e.g. liquefy, or evaporate), but more generally its temperature rises. The temperature changes brought about by the radiant heat from the Sun are among the chief causes of the variations in weather and climate over the globe.

Distribution of Insolation.—The name insolation is given to the radiant energy emitted by the Sun. The distribution of insolation upon different parts of the surface of the globe varies considerably (see Fig. 57). This may be seen by imagining bundles of rays of equal dimensions (X, Y and Z) ; these fall on areas indicated by the shading at ab, $a'b'$, and $a''b''$ respectively, and the diagram shows that these areas increase towards the poles, so that the same amount of insolation is spread over larger and larger areas as the Sun's rays strike the Earth more obliquely, and thus the amount received on each square centimetre of the surface diminishes. This diagram shows the Earth and Sun at the equinoxes, and similar diagrams constructed for the summer and winter solstices (cf. Figs. 16 and 17) would show how the distribution of insolation varies with latitude at these seasons. All these figures would show the angle of incidence of

the Sun's rays at noon, but owing to the Earth's rotation this angle will vary through the day from zero at sunrise and sunset to its maximum noon-tide value (see Figs. 18, 19 and 20). Hence the amount of insolation varies from hour to hour during the day, and since it is measured by the quantity of heat received at the surface per minute, it is necessary to take into account the length of time that the Sun is above the horizon. At the equinoxes this is twelve hours all over the globe, but towards

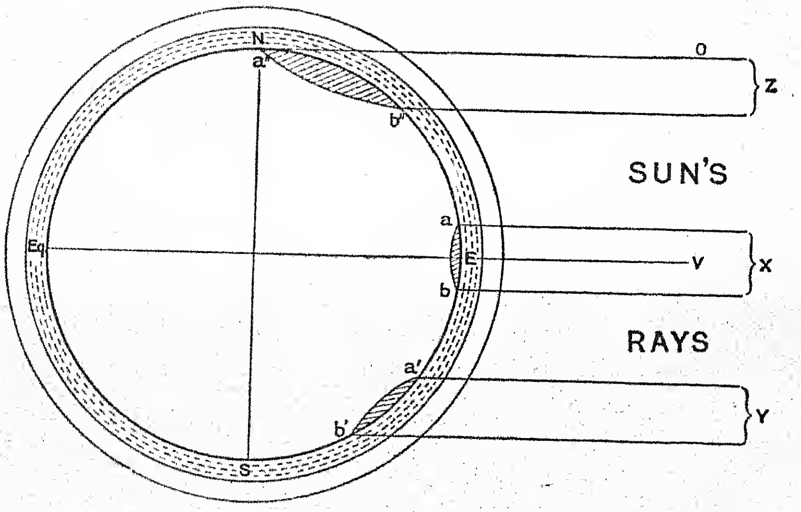


FIG. 57.—Distribution of Insolation over the Globe.

the summer solstices, the longer days of high latitudes more than compensate for the greater obliqueness of the Sun's rays, and the total insolation for the day is greatest, not at that latitude where the Sun is highest at noon, but at some higher latitude which has longer hours of daylight (see Fig. 15).

So far it has been assumed that all the radiant energy from the Sun reaches the Earth's surface, but this is not the case, for a large proportion, about 60 per cent., is absorbed by the atmosphere. The amount absorbed varies according to several factors; it is proportional to the thickness of atmosphere passed through, to the density of the atmosphere, and to the number of

particles, such as those of water and dust, present in the air. A consideration of Fig. 57 shows that a ray *ON*, falling obliquely, passes through a greater thickness of atmosphere than a ray *VE* falling vertically; moreover, the oblique ray passes through a much greater proportion of the lower atmosphere (dotted) than the vertical ray, and it is the lower atmosphere which, being denser and more impure, has the greater absorbing power. As a result, the amount of insolation reaching the Earth's surface diminishes, at first slowly, and then more rapidly as the obliqueness of the rays increases.

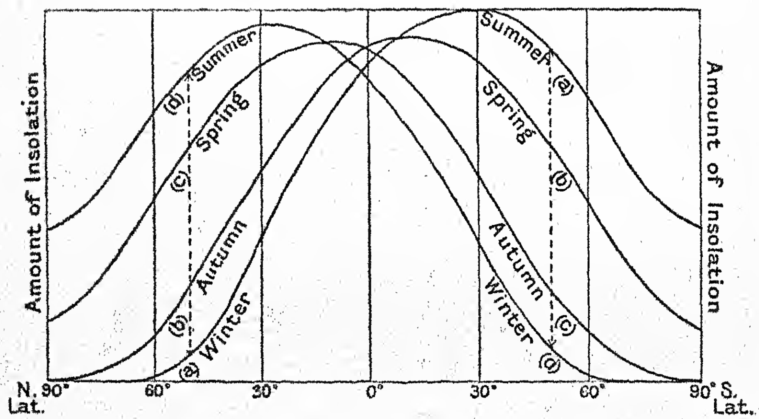


FIG. 58.—Seasonal Distribution of Insolation at Different Latitudes.

Fig. 58 shows graphically the amount of insolation received at different latitudes during the four periods, (*a*) December-January-February,[1] (*c*) March-April-May, (*d*) June-July-August, and (*b*) September-October-November. The greatest amount (where the curves are highest) is received at about 30° N. in the northern summer, and at about 30° S. in the southern summer; the least amount is received near the north and south poles where for part of the year the Sun remains below the horizon. The most uniform conditions through the year are found near

[1] Note that this period is marked "winter" in the part of the graph referring to the northern hemisphere, and "summer" in the part referring to the southern hemisphere; and that similar changes of season are marked against the other curves.

the equator, where the curves for all seasons are close together, while the most varied conditions are found at latitudes 50° N. and S., where the summer and winter curves are farthest apart.

Near the equator the greatest insolation occurs at the season of the equinoxes (compare Fig. 18), while elsewhere it occurs in the season of the summer solstice (compare Fig. 19).

The Zones.—Owing to the importance of the relation between the Arctic and Antarctic circles and the tropics on the one hand, and the distribution of insolation on the other, these parallels of latitude are used to divide the globe into climatic zones. Between the north and south tropics lies the Torrid Zone, where every place has vertical insolation twice a year (see p. 36), and where the longest day is only $13\frac{1}{4}$ hours; between the tropics and the circles lie the north and south Temperate Zones where there is never vertical insolation, and where the difference between the lengths of the summer and winter days is increasingly great; between the circles and the poles lie the Frigid Zones where the long "days" last from twenty-four hours to six months (see p. 30), and where the altitude of the Sun is never great (see Fig. 20). A reference once more to Fig. 58 shows that in the Torrid Zone the amount of insolation is uniformly great, in the Temperate Zone the amount varies considerably with the seasons, while in the Frigid Zone the amount is never great, and the seasonal variations are moderate.

The Temperature of the Earth's Surface.—The general effect of insolation is to raise the temperature of the body upon which the rays fall, but the Earth's surface is composed of two elements, land and water, which re-act very differently to heat. If equal volumes of land and water with equal surfaces could be exposed to exactly the same insolation, the temperature of the land would be raised 1·7° C., while that of the water was raised 1° C. This may be otherwise expressed by saying that the land would be heated more rapidly and to a higher temperature than the water. Other factors intensify this contrast between land and water: solar radiations cannot penetrate the solid land, so that all the heat is used to raise the temperature of a thin surface layer, while the more transparent water is heated to a greater depth; the mobility of the water results in fresh particles

being constantly exposed to the rays; finally, some of the heat is expended in evaporating the water and not in raising its temperature.

Temperature conditions do not depend only upon the quantity of heat received; they are due to the balance between this and the heat lost by radiation from the Earth's surface. Whereas insolation can only proceed while the Sun is above the horizon, the loss of heat by terrestrial radiation is continuous throughout the twenty-four hours. So long as the quantity of heat lost by radiation exceeds the quantity received by insolation the temperature falls, while when the insolation is the greater the temperature rises. Thus the minimum temperature for the day may occur some hours after sunrise, because the feeble insolation from the early morning Sun is not sufficient to balance the radiation, while the maximum temperature may occur some hours after noon, because although the insolation is decreasing, it is still in excess of the radiation. In the same way during winter in high latitudes the radiation of the whole of the twenty-four hours constantly exceeds the insolation of the short hours of daylight, so that the temperature falls until about January, while in the summer the insolation constantly exceeds the radiation, and the temperature continues to rise until about July.[1] Since, however, the Earth as a whole gets neither hotter nor colder as the years go on, the mean annual radiation must just balance the mean annual insolation.

Terrestrial radiation, like insolation, is checked by the presence of water and dust particles in the air, so that it is less on a cloudy night than on a clear night.

Just as the same amount of insolation causes a slower and smaller rise of temperature in a water surface than in a land surface, so the same amount of radiation causes a smaller fall of temperature. In other words, water cools more slowly and to a less extent than a land surface under the same conditions.

[1] Thus in Britain, January is usually the coldest month, although the Sun has its lowest noon altitude and shortest course in December; similarly, July and not June is usually the hottest month. For the same reason, the temperatures of January and July are generally taken in studying seasonal changes over the World as a whole.

The slow cooling and heating of a water surface, and the rapid cooling and heating of a land surface, have very important consequences. The daily and seasonal changes of a water surface are comparatively slight; those of a land surface are well marked. A water surface is cool in summer relatively to a neighbouring land surface, while in winter it is relatively warm; this is especially the case in high latitudes where the difference in the amount of insolation in summer and winter is well marked, but in equatorial regions where the insolation is uniformly high through the year, the land is always warmer than the sea during the day.

Temperature of the Air.—So far the temperature of the Earth's surface itself has been considered, but the temperature of the lower atmosphere is of far more importance to plants, animals and man.

The absorption of radiant energy which takes place as the Sun's rays pass through the atmosphere does not appreciably raise the air temperature, so that the upper atmosphere is permanently cold while the lower atmosphere obtains its heat from the Earth's surface. The method by which the air is heated is as follows. The layer of air in contact with the surface becomes heated by conduction, and as this results in it becoming lighter than the surrounding air, it is displaced upwards by the latter; then fresh particles come in contact with the Earth, to be warmed and displaced in their turn. Moreover, the warm particles as they move upwards lose part of their heat to neighbouring colder particles, and thus by degrees a thick layer of air is warmed. The method of cooling is slightly different. The lower layers of air lose heat by conduction to the cold surface, but as this fall of temperature makes them heavier, they do not move away. The higher layers lose heat by radiation to the cold earth, and to a less extent by radiation into space. Thus both heating and cooling take place gradually, the lowest layers of air being first affected, and then by degrees the higher. It follows that at night the upper air is frequently warmer than the lower; this is known as "inversion of temperature."

The statements made with regard to the amount of insolation at different latitudes (p. 84), and to the temperature relations of land and water surfaces, may now be applied to the temperature

of the air. The air in equatorial regions is uniformly hot through the year. In temperate regions hot summers alternate with cold winters, but over the oceans the summers are relatively cool, and the winters relatively warm; also the daily changes over the ocean are less than those over the land. In the Frigid Zone the air is very cold in winter, and cold or cool in summer.

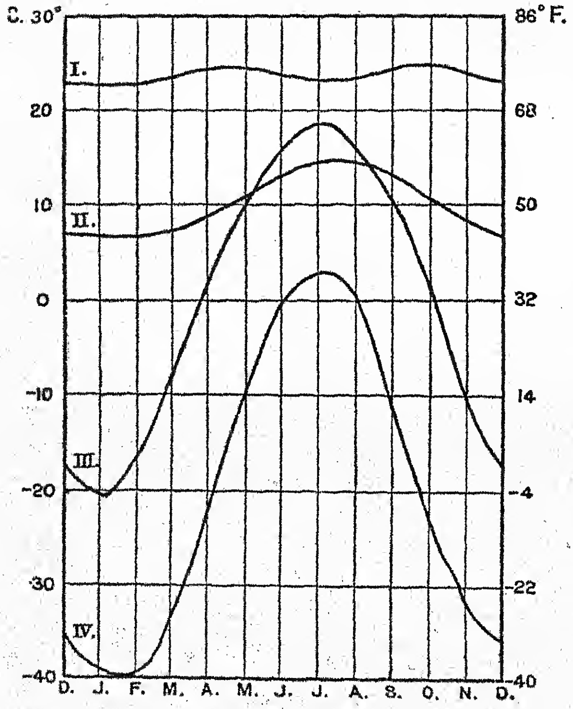


Fig. 59.—Graphs showing the Mean Monthly Temperatures at Four Stations. I, Batavia; II, Valentia; III, Irkutsk; IV, Fort Conger.

The graphs given in Fig. 59 illustrate these points. Batavia shows equatorial conditions; Valentia (on the Irish coast) shows oceanic conditions in the Temperate Zone; Irkutsk shows the land conditions in the same zone, while Fort Conger shows the march of temperature in the Frigid Zone. These curves show the mean conditions for each month, but the daily temperatures vary considerably from the mean.

The chief factors other than the amount of insolation which help to determine temperature are: (1) cloudiness; (2) winds; (3) ocean currents. Clouds, which are a mass of tiny drops of water (or sometimes particles of ice), check both insolation and radiation, so that a cloudy day is cool and a cloudy night warm. Winds have a varying effect according to their place of origin; thus a sea-breeze may be warm in winter and cool in summer, and a land-wind hot in summer and cold in winter.

The direction of the prevailing wind is very important, especially in high latitudes where great seasonal temperature variations are the rule. For example, a sea-board which has prevailing on-shore winds will reflect the characteristic temperature changes of the ocean, as in the case of Valentia, while a sea-board with a prevailing off-shore wind will reflect the characteristic temperature changes of the land to the windward side, which will only be slightly modified by the neighbourhood of the sea.

The influence of ocean-currents is indirect: they bring cold water from higher latitudes or warm water from lower latitudes, and the altered temperature of the water surface affects the air above; hence the winds which blow from the area affected are exceptionally cool or warm as the case may be.

Temperature and Altitude.—It has already been explained (p. 87) how the heated surface of the Earth gradually raises the air temperature at higher and higher levels, but in spite of the constant ascent of the warmed air the temperature decreases rapidly with altitude. This is because the air as it rises becomes rarefied, i.e. expands, and the expansion is accompanied by a definite fall of temperature. It is calculated that pure dry air would cool 1° F. for every 180 feet of ascent, or 1° C. for every 100 metres. This, however, is a theoretical calculation which does not correspond with rates of cooling actually observed, for there are always some disturbing elements, such as the existence of water vapour which retards the rate of cooling, as explained later in Chapter VIII.

In the case of elevated land surfaces, such as plateaus or mountains, other factors must be considered. If the surface is, for example, 3,000 feet above sea-level, the thickness of atmo-

sphere through which the Sun's rays pass is so much the less, moreover the air at this elevation is more free from dust and cloud and is less dense than the lower air; hence the amount of insolation reaching the surface is much greater than at sea-level. On the other hand the radiation from the surface is more rapid for exactly the same reasons, and this is continuous throughout the twenty-four hours. Yet another factor influences radiation from the surface, for this proceeds more rapidly if the air is free from invisible water-vapour and from carbon dioxide, and the upper air is poorer in these gases than the lower air. Hence on the average the temperature of the air on elevated surfaces is lower than at sea-level.

It is, therefore, clear that, owing to the complicated set of conditions upon which the air temperature depends, the actual variations with altitude differ from night to day, and from season to season, but numerous observations give as an average value a lowering of 1° F. with every 300 feet above sea-level, or of 0·6° C. for every 100 metres.

Temperature Maps.—Owing to the diversity of relief over the Earth's surface, a map showing the actual temperature conditions

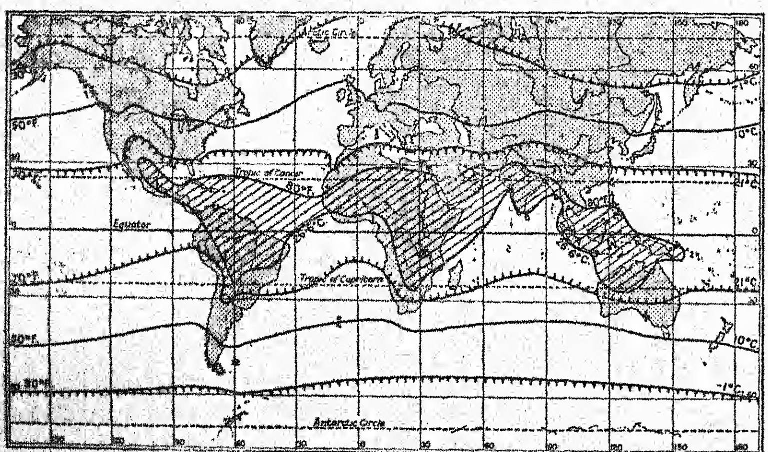


Fig. 60.—Mean Sea-level Temperatures for October (after Buchan).

is very complicated. It is usual to make use of the average figures given above to eliminate the effect of altitude upon

temperature, and all observations are mapped as though the station were at sea-level. For example, if the reading for a station 600 feet above sea-level is 50° F., it is mapped as 52° F. Lines joining places with an equal temperature are called isotherms; thus the isotherm marked 50° F. (10° C.) passes through all places which have that temperature after reduction. Fig. 60 shows the isothermal map of the World (observations reduced to sea-level) for October. Between the tropics the temperatures are almost everywhere above 70° F. (21° C.), and over the lands they are above 80° F. (26·6° C.). Beyond the tropical belts, the temperature diminishes fairly regularly towards the north and south poles, the isotherm of 50° F. (10° C.) following roughly parallels 45° N. and S., the isotherm of 30° F. (—1° C.) following roughly parallels 60° N. and S.

January Isotherms.—Fig. 61 shows the isotherms for January. The hot belt (over 20° C.) has moved southward with the belt of maximum insolation, as it is summer in the southern hemisphere. The highest temperatures (over 30° C.) are found in the interiors of the southern land masses, for the temperature of the land rises rapidly with the increased insolation. On the other hand, the ocean temperatures between the tropics have changed but little since October. In the northern hemisphere the equatorward bending of the isotherms over Western America and Western Europe shows that the land is colder than the sea as it is winter in these latitudes, while in the southern hemisphere the isotherms bend pole-wards over the land, showing that here the land is warmer than the sea. The coldest part of the world is in the north of Siberia, where there is an area below —40° C. (the "cold pole"). In the great land mass of Asia, the isotherm of 0° C. reaches within 35° of the equator, while the same isotherm in the Norway Sea is within 20° of the pole.

July Isotherms.—Fig. 62 shows the isotherms for July. The hot belt (over 20° C.) has moved northward with the belt of maximum insolation, as it is summer in the northern hemisphere. The hottest areas are the interiors of the northern land masses where the temperatures are over 30° C. The isotherm of 20° C. goes farthest north over the great land mass of Asia, where it reaches within 30° of the pole. The pole-ward bending of the

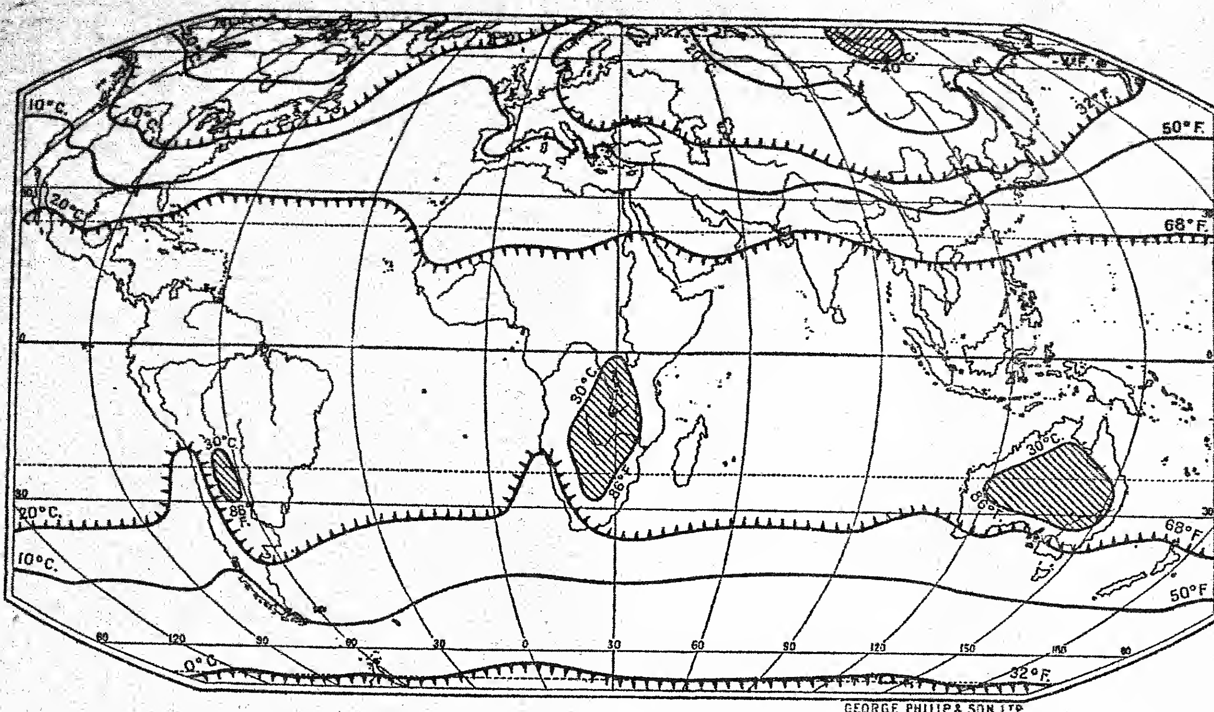


FIG. 61.—Mean Sea-level Temperatures for January (after Hann).

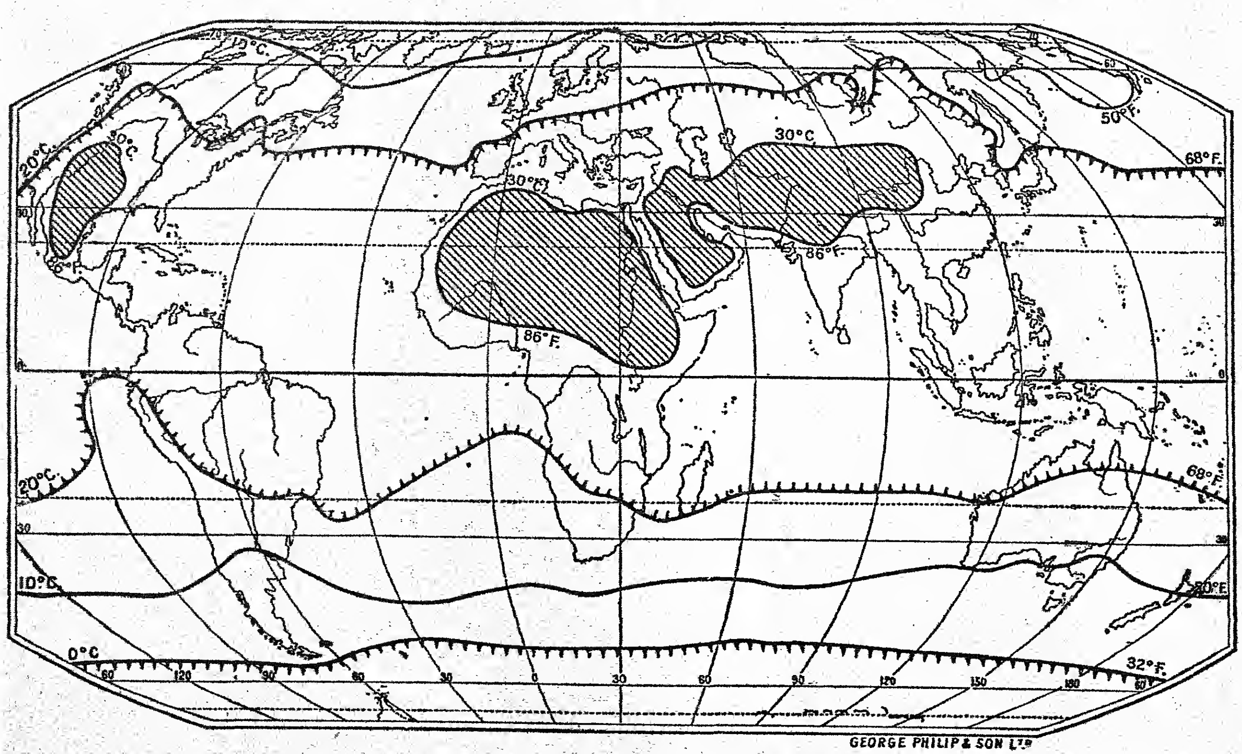


FIG. 62.—Mean Sea-level Temperatures for July (after Hann).

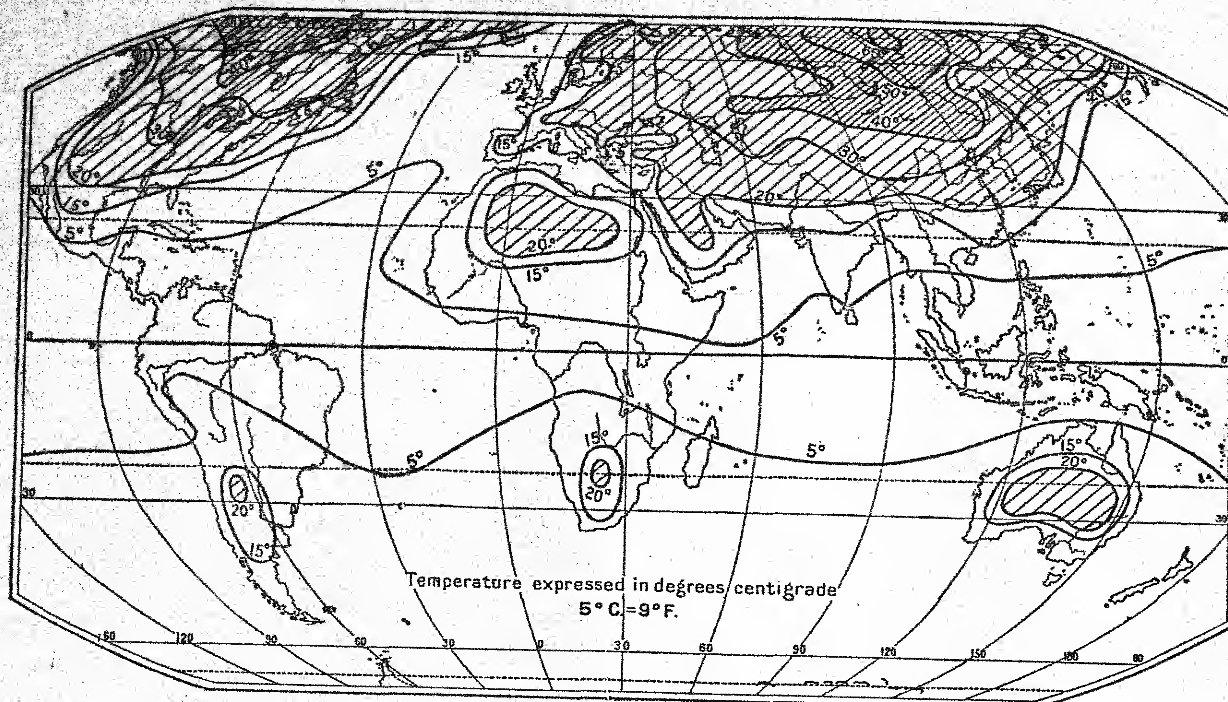


Fig. 63.—Mean Annual Range of Temperature (after Supan).

isotherms over the northern land masses shows that the land is hotter than the sea in the same latitudes. The equator-ward bending of the isotherms round Lake Baikal and the Great Lakes of North America shows the cooling effect of these areas of water.

Annual Range of Temperature.—Fig. 63 shows for all parts of the world the difference between the mean temperature of the hottest month and that of the coldest month ; this difference is known as the mean annual range of temperature. Where the mean annual range of temperature (i.e. the amount of the change experienced as between the hottest and coldest months at a place) is above 20° C. (36° F.) the climate may be said to be extreme ; where it is below 15° C. (27° F.) the climate may be said to be equable. Thus in July the north of France has a temperature of about 20° C. (see Fig. 62) ; in January the mean temperature is about 5° C. (see Fig. 61) ; the mean annual range is therefore 15° (see Fig. 63), and the climate is therefore not extreme ; were the range less it would be distinctly equable. The range over the seas and the lands near the equator is very small, because here the amount of insolation is very uniform through the year (see p. 84). It increases towards the interiors of the tropical land masses, as the land temperatures reflect the changes of insolation more rapidly than the oceans. It is very great in the land masses of high latitudes because here the seasonal difference in the amount of insolation is also great. The immense continent of Asia shows greater ranges than the smaller continent of America, because the interior of Asia is more remote from the moderating influences of ocean winds.

For list of Authorities and Books for further reading see bibliography at end of Chapter IX.

CHAPTER VII

ATMOSPHERIC PRESSURE AND WINDS

The temperature changes of the air discussed in the previous chapter are accompanied by changes of volume. When air is heated it expands, when it is cooled it contracts; it is upon these properties that the atmospheric circulation depends. If a quantity of air is introduced into a collapsible balloon, the walls of the balloon are distended until the air occupies a definite volume. The force which keeps the walls distended must be exerted by the air, which is pressing them outwards in all directions; it may be termed the elastic force of the air. Air may be likened to a spiral spring; if it is compressed its elastic force is increased. Since air has weight, the upper layers of the atmosphere must compress the lower, and so increase their elastic force. Consider a very small portion of air at rest: all the forces acting upon it must balance one another, for if not, it would move. Its elastic force acts outward in all directions, and since the air does not move upwards, this force must just be balanced by a force acting downwards, namely the weight of the air above it. Hence the weight of the column of air above any particular level in the atmosphere may be taken as the measure of the elastic force exerted by the air in that level.

The term atmospheric pressure is usually employed rather than elastic force; it is measured by means of a barometer. This instrument consists essentially of a glass tube, closed at one end, which is completely filled with mercury, then inverted, and the open end plunged into a cup of mercury. Part of the mercury runs from the tube into the cup, and a column some thirty inches high remains; at the top of the tube a vacuum is formed. In Fig. 64, *AB* is a horizontal mercury surface.

Since it is at rest all the vertical forces acting on it must be equal. These are the weight of the atmosphere outside the tube, and the weight of the mercury column *h* inside the tube. If the weight of the atmosphere increases, more mercury will be pressed up the tube, until the weight of the mercury again balances that of the air. If the weight of the atmosphere decreases, mercury will flow down from the tube until the balance is again restored. Thus the height of the mercury column can be taken as the indication of the weight of the super-incumbent atmosphere at any point, and this is equal to the elastic force or pressure of the atmosphere at that point. Thirty inches or 760 mm. (1,013 millibars) is a normal pressure; figures above this value may be termed "high," those below it "low."

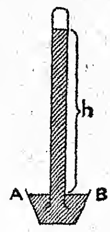


FIG. 64. Principle of the Barometer.

Pressure and Altitude.—It is clear that the atmospheric pressure must decrease with altitude, but the rate of decrease cannot be represented by a simple arithmetical progression. If a barometer is carried from sea-level to a height of some thousands of feet, the mercury column will fall for two reasons: the height of the column of air above the mercury in the cup is diminished, and at the same time the air that forms this column is rarefied. The barometer will fall an inch if carried from sea-level to an altitude of 910 feet, but to cause it to fall another inch it must be carried more than 910 feet higher. At an altitude of 9,330 feet it must be carried up a further 1,220 feet before it falls an additional inch, that is to say that a column 1,220 feet high of the rarer air at these high altitudes just balances a column 910 feet high of the denser air at sea-level. At an altitude of about 16,000 feet the pressure is about half that at sea-level; the rarefied air is insufficient for human needs, and mountain sickness (headache, nausea, dizziness, difficult breathing) is the result. Many people suffer from mountain sickness at still lower levels, so that, apart from other considerations, the loftier plateaus and mountains of the world can never be inhabited.

Temperature and Pressure.—Differences of pressure at the

same level above the sea are constantly brought about by differences of temperature, which cause expansion or contraction. In Fig. 65, *MNOP* represents a portion of the Earth's surface on which the pressure is (say) p inches. In a higher plane, *ABCD*, the pressure is less and may be represented as $(p-a)$ inches), sufficient to balance the weight of the air above that plane. If the portion of the surface *NO* is maintained at a higher temperature than the portions *MN* and *OP*, the air above it will become heated and expand. The air which occupied the column *BCON* now occupies the column *B'C'ON*, and some of the air formerly below the level *BC* has been lifted above it; this increases the weight of air upon *BC*, so that the pressure on this plane becomes greater, (say) $(p-a)+b$ inches. The pressure on *AB* and *CD* remains unchanged, and is $(p-a)$ inches; hence the air on *BC*, pressing outwards with a force $(p-a)+b$ inches, and resisted only by a force $(p-a)$ inches, moves outwards as shown by the arrows.[1] This movement alters the pressures at the surface *ABCD*. Air has been removed from above *NO*, so that the pressure is now less, (say) $(p-c)$ inches. Air has accumulated above *MN* and *OP*, so that the air here is made denser and its pressure may be represented as $(p+d)$ inches. Hence the cooler and denser air flows inwards towards the low pressure area, and forces the heated air upwards, as shown by the arrows. As long as the supply of heat is maintained, the air in the central column will move upwards and

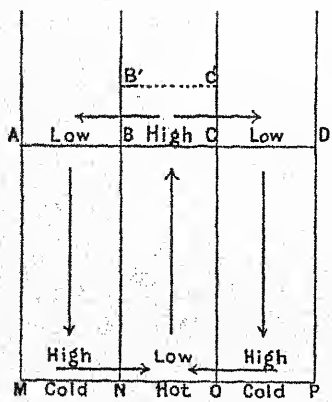


FIG. 65.—Diagram showing the Relation between Temperature, Pressure and Air-currents (I).

[1] Note that the words " High " and " Low " in the diagram refer to the relative pressures in one plane only; thus, in Fig. 65 " High " in the upper part of the central column indicates a pressure greater than that on either side, but less than that at the surface beneath, although this latter pressure is marked " Low."

outwards, while the air in the side columns will be compressed, settle down, and move inwards. In this way a complete system of what are termed convection currents is set up. The reverse case of a column of air maintained at a lower temperature than its surroundings is shown in Fig. 66. The cold air contracts so that the column *BCON* occupies the new volume *B′C′ON*. Some of the air which before rested on *BC* is now below it so that the pressure $(p-a)$ inches on *BC* is reduced to $(p-a)-b$ inches. The pressure on *AB* and *CD* is still $(p-a)$ inches, so that the air here moves inwards as shown by the arrows. This increases the pressure on *NO*, while diminishing that on *MN* and *OP*, hence at the surface there is an outflow of air from the cold area. In the central column the low temperature and the compression due to inflow of air above cause a general down settling, while in the side columns the removal of air above and the outflow of air along the surface from the central portion cause a general uplift. Thus again a complete circulation is established which is kept up as long as the temperature difference which caused it is maintained. To summarise the above results: Wherever a region, large or small, has its temperature maintained above or below that of neighbouring regions, definite pressure changes and air movements result. In a region of high temperature, a low pressure is developed, accompanied by inflowing winds at the surface and an upward drift above the centre of low pressure. In a region of low temperature a high pressure is developed, accompanied by outflowing winds at the surface, fed by a down settling in the area of high pressure. The rising currents in the heated areas are termed convection currents.

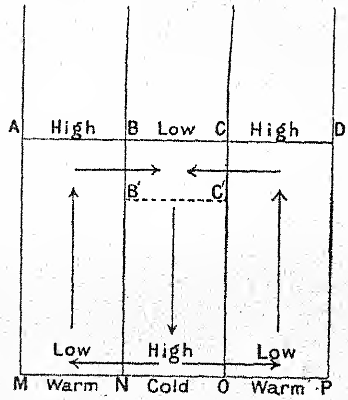


FIG. 66.—Diagram showing relation between Temperature, Pressure and Air-Currents (II).

Distribution of Pressure over the World.—Applying these principles to the World distribution of temperature and pressure, it

follows that since the temperature diminishes from the equatorial belt towards the poles, the pressure should increase in the same direction. In the lower atmosphere the air should flow from the poles towards the equator, while in the upper atmosphere this direction should be reversed. Fig. 67 shows the sea-level pressures for October. A low pressure belt corresponds to the equatorial hot belt, and the pressure increases pole-wards as far as latitudes 30°–40° north and south, but here the belt of maximum pressure is found, for in yet higher latitudes the pressure once

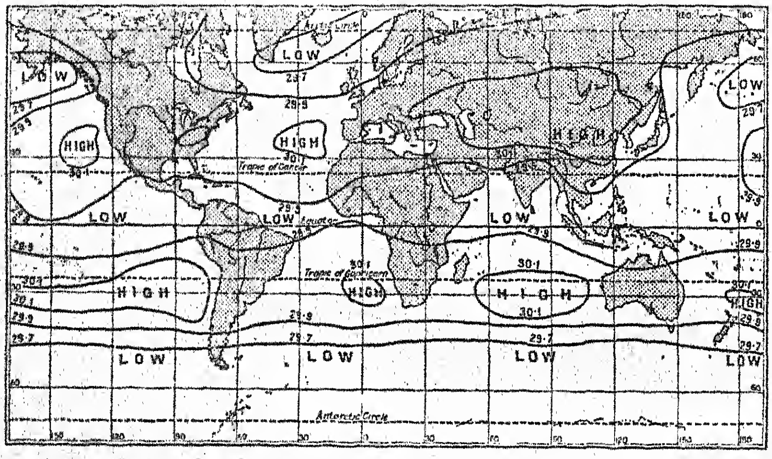


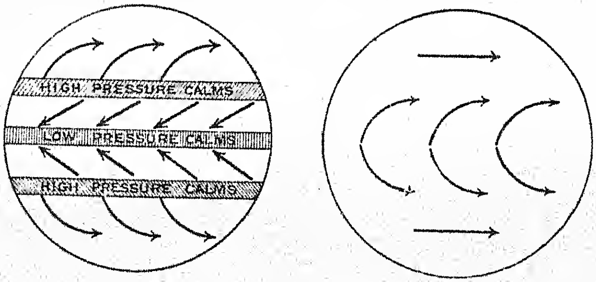
FIG. 67.—Mean Sea-level Pressures for October (after Buchan). [The Figures denote Inches.]

more diminishes. The distribution of temperature fails to account for the highest pressure being in middle latitudes instead of around the poles. Moreover, observation shows that the winds blow, not directly from the high pressure towards the low pressure areas as the above explanation suggests, but obliquely, the expected north winds becoming north-east, south winds south-east, and so on.

Effect of the Earth's Rotation.—To account for these difficulties a new factor has to be considered, namely the Earth's rotation. All moving bodies are possessed of the property of inertia, that is to say they offer resistance to any change in the

direction or velocity of their motion. Hence a wind once set in motion tends to keep moving in the same direction although the Earth rotates beneath it; compared therefore to the Earth's surface a wind appears to change its direction.[1]

The Earth rotates from west to east, and a person situated above the north pole would have the northern hemisphere rotating to his left; compared with the Earth, therefore, a wind moving over the northern hemisphere is deflected to the right. Similarly, a person situated above the south pole would have the southern hemisphere rotating to his right (as a globe will demonstrate), and, compared with the Earth, a wind moving over the southern hemisphere is deflected to the left.



I. II.

FIG. 68.—The Planetary Winds. (I) Surface Winds—The N.E. and S.E. Trades and the Westerlies. (II) Winds of Upper Atmosphere.

Thus any wind in the northern hemisphere shows a deflection to the right of the path which it would take if the Earth were at rest, while any wind in the southern hemisphere shows a deflection to the left. At the equator itself there is no deflection, and the amount of the deflection increases as the poles are approached. It also increases as the frictional resistance

[1] The wind may be compared with Foucault's pendulum (see p. 17) for it tends to keep its direction unchanged just as the pendulum tends to keep the plane of its swing unchanged, while the Earth twists away beneath it. The effect is quite independent of the original direction of the wind (i.e. whether from the north, south, east or west) just as the apparent deviation of the pendulum is independent of the direction in which it is set swinging.

offered to the movement of the particles decreases. The only steadily moving bodies on the Earth's surface are water and air; in the case of the water the frictional resistance between the moving layers is so great that the deflection is small, in the case of air where the friction is much less, the deflection is considerable.

Taking this new factor into account, the effect of the pressure differences set up in the upper atmosphere, owing to the expansion of air above the equator and the contraction at the poles, may be considered. They should lead to strong winds blowing pole-wards at a high level, causing an accumulation of air and a high pressure at the poles. But these upper air currents are deflected as are any other winds, and since there is but little friction in the upper air (which is rarer than the lower air) the amount of deflection is very great (see Fig. 68 II). Between 30° and 40° N. and S. lat. the direction of movement becomes nearly due east, so that the pole-ward component almost disappears and the air moves from west to east round the poles. As a result the upper air moving away from the equator tends to get massed in these latitudes, and so produces at the surface high pressure belts, while in higher latitudes the surface pressure is relatively low, because the circum-polar movement tends to reduce the amount of air near the centre of the swirls, as in a basin of water a swirl reduces the amount of water in the centre; thus the distribution of pressure in October is explained. At the surface the air moves away from the high pressure belt both equator-wards and pole-wards; the resultant winds at the surface are shown in Fig. 68 (I).

Planetary Winds.—The equatorial low pressure belt is a region of upward drift with calms at the surface; this belt is known as the doldrums. The high pressure belt is a region of down settling air and surface calms; this belt is known as the horse latitudes. Between the horse latitudes and the doldrums blow the steady trade winds which move toward the equator, and being deflected to the right in the northern hemisphere and to the left in the southern hemisphere are respectively NE. and SE. winds. Beyond the horse latitudes lie the belts of winds known as the stormy "westerlies"; these winds tend to blow pole-wards, but owing to the deflection are from the SW. and W.

in the northern hemisphere, from the NW. and W. in the southern hemisphere. This whole system of wind and pressure belts shifts northwards and southwards in harmony with the movements of the hot equatorial belt to which it is in the first instance due. A similar system, determined by the distribution of insolation, would be set up on any rotating planet having an atmosphere. Hence the name planetary winds is given to this general circulation.

Monsoon Winds.—The regularity of the planetary wind system is destroyed by the temperature differences between land

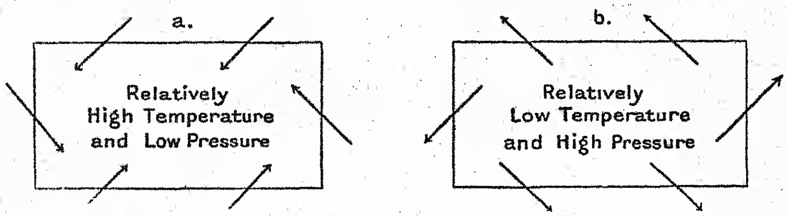


FIG. 69.—Scheme of Monsoon Surface Winds. (*a*) Summer Monsoon in the Northern Hemisphere. (*b*) Winter Monsoon in the Southern Hemisphere.

and water. The lands in summer are warmer than the seas, and hence become areas of relatively low pressure, while in winter they are colder than the seas, and become areas of relatively high pressure. Wherever these temperature and pressure differences are sufficiently strongly marked, the normal planetary winds are replaced by monsoon winds which in summer blow landwards towards the low pressure areas, and in winter are reversed and blow seawards away from the high pressure areas. Fig. 69 shows schematically the direction of these winds on the different coasts of a land mass, taking into account the deflections due to the Earth's rotation.

Pressure Gradients.—The strength of the wind blowing between two points is proportional to the difference of pressure between them ; when this is great the wind is strong and steady, but when it is small the wind is light and variable, easily altered by such slight causes as relief or local temperature changes. Pressures, like temperatures, are reduced to sea-level before they are mapped, and hence the maps show the actual conditions only over the oceans and lowlands. The lines of equal pressure are called isobars. When they lie close together a rapid change of

pressure from point to point at right angles to the isobars is indicated, and the gradient is said to be steep (cf. contour lines); when they lie far apart the gradient indicated is slight.

With a steep gradient, the winds tend to blow parallel with the isobars, only slightly inclining down the gradient, this being due to the Earth's rotation. The result is that an observer with

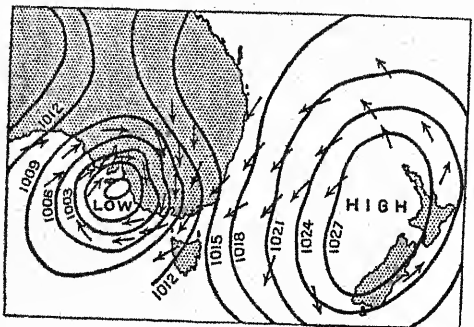


FIG. 70.—Wind and Pressure Gradient: Southern Hemisphere.

his back to the wind has the lower pressure on his left, a statement known as Buys Ballot's Law: in the southern hemisphere the lower pressure is on the observer's right. Fig. 70 shows a common arrangement of the isobars of middle latitudes, namely in closed curves. There is a gradient towards a low pressure centre off Adelaide, and away from an area of high pressure east of New Zealand.

Pressure and Winds in January.—In Fig. 71 the planetary system of trade and westerly wind belts shown diagrammatically in Fig. 68 can be recognized over the Atlantic, Pacific and South Indian Oceans. In the southern hemisphere the westerly winds make a continuous belt round the globe, but in the northern the low temperature of the land masses interferes with the arrangement of the isobars, and oval low pressure areas are formed over the warmer oceans. The winds blow obliquely in towards these areas, so that westerly and south-westerly winds are found to the south and east of them (including the western margins of the continents), while north-westerly winds are found to the west of them (including the eastern margins of the continents). To

the north of these low pressure areas north-easterly winds blow out from the polar regions, and the few observations made in the south polar seas seem to show that here also, beyond the belt of the westerlies and north-westerlies there are south-easterly winds blowing out from the Antarctic Continent. A winter monsoon system is found in Asia, which is a centre of high pressure and outflowing winds, while a summer monsoon system is found in Northern Australia, which is a centre of low pressure and inflowing winds. The pressure and wind directions agree with Buys Ballot's Law, and it is noticeable that the deflection due to rotation is greatest in higher latitudes where the winds blow almost parallel to the isobars. The steep gradients in North-east Asia make the northerly and north-westerly monsoon winds stronger than the north-east monsoon which blows from Southern Asia. Over North America the cold weather high pressure is less marked, but it is sufficient to cause an outflow of air from Canada which joins the south-westerly system over the North Atlantic.

Pressure and Winds in July.—Fig. 72 shows the conditions for July. The equatorial low pressure belt across the Atlantic and Pacific Oceans has shifted several degrees northward in harmony with the northward movement of the equatorial hot belt. A comparison with the January map shows that the trade and westerly wind belts have also moved towards the north. In the northern hemisphere owing to the interference of the land masses the westerly winds which blow out from the northern margins of the high pressure areas (lats. 30°–40° N.) are only well marked over the Atlantic Ocean, with Eastern Canada and Europe, and over the eastern part of the Pacific Ocean. The monsoon systems over Asia and Australia are now reversed. Northern India and Persia form the centre of a low pressure system, and over the whole of Asia the pressure is low relatively to that over the surrounding seas, so that the winds blow obliquely towards the land ; they are strongest in the south (the south-west monsoon) where the gradients are steepest. These winds are largely fed from the high pressure area of the Southern Indian Ocean and from Australia, which now has its winter conditions of high pressure and (in the north) out-flowing winds.

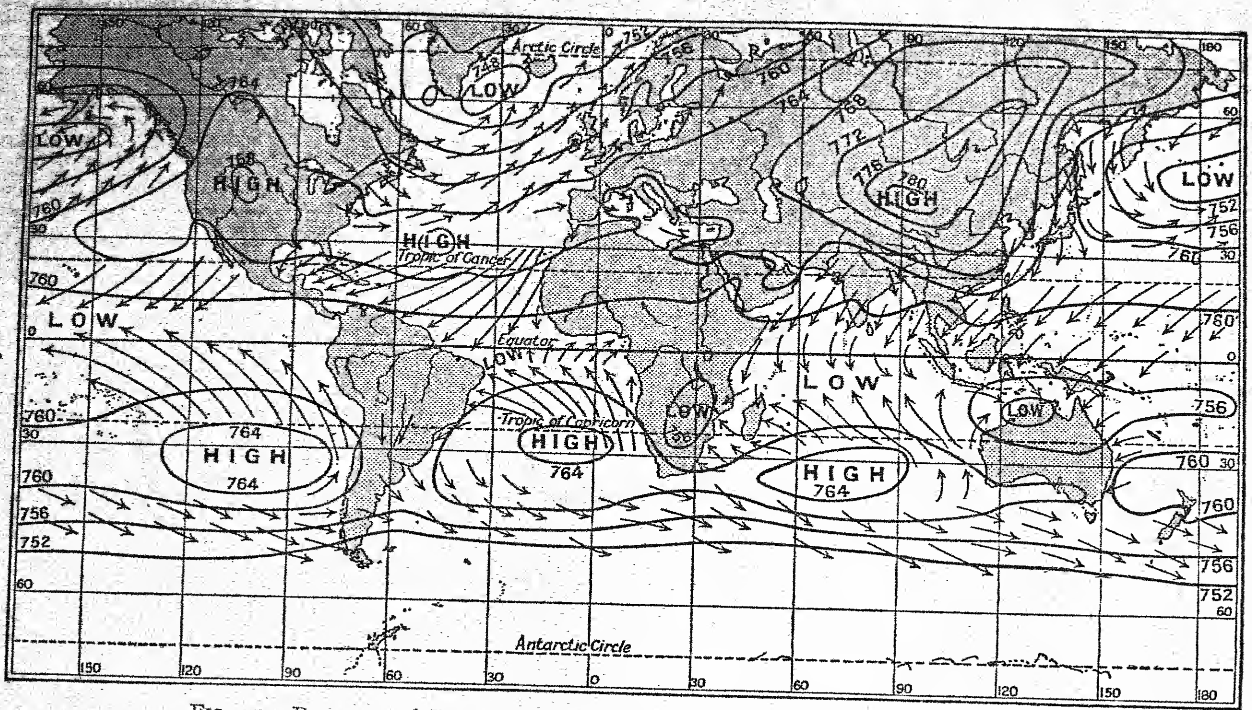


FIG. 71.—Pressure and Winds for January (after Hann and the Deutsche Seewarte).

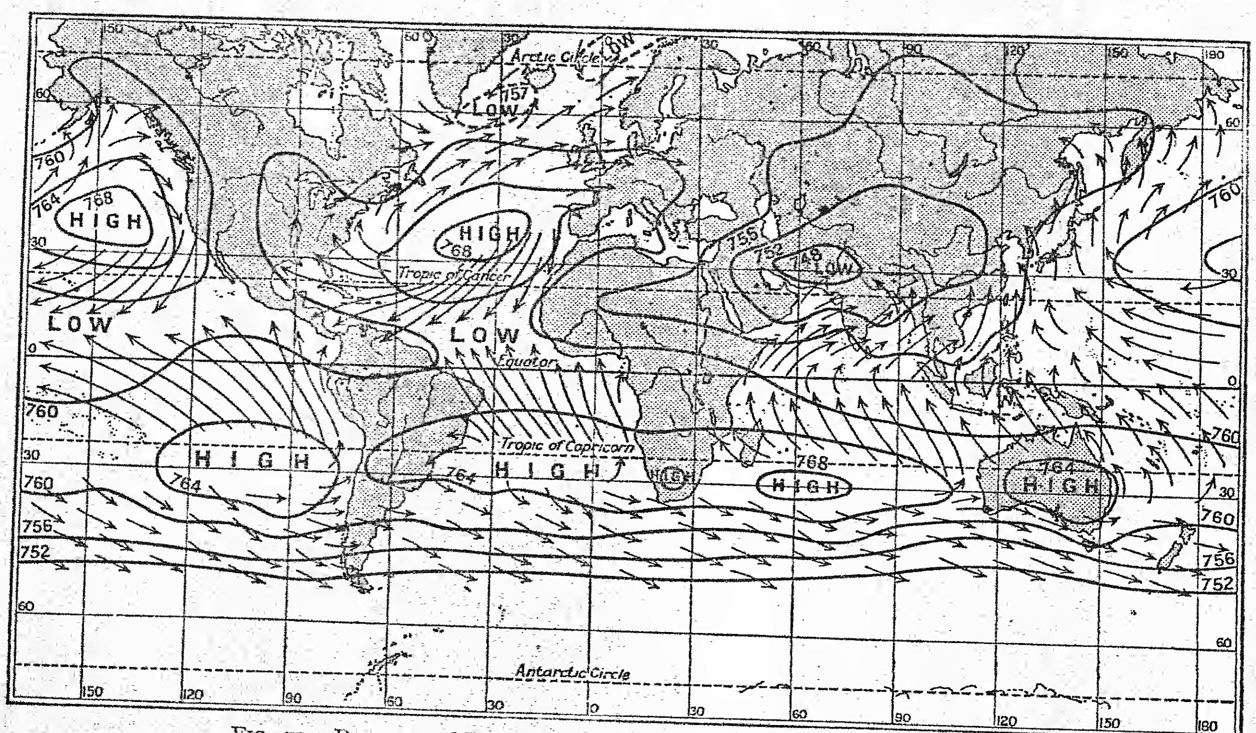


FIG. 72.—Pressure and Winds for July (after Hann and the Deutsche Seewarte).

Cyclones and Anticyclones.—In the regions of the stormy westerlies the wind directions are much less constant than in the trade wind belts. This is because the daily pressure conditions often differ very widely from the averages shown on the monthly maps. Instead of a uniform fall of pressure over the North Atlantic from a high pressure centre at about latitude 30° N. to a low pressure centre at about latitude 60° N., the distribution of pressure is of the type shown in Fig. 73, resembling that shown for Australia in Fig. 70. The high pressure systems

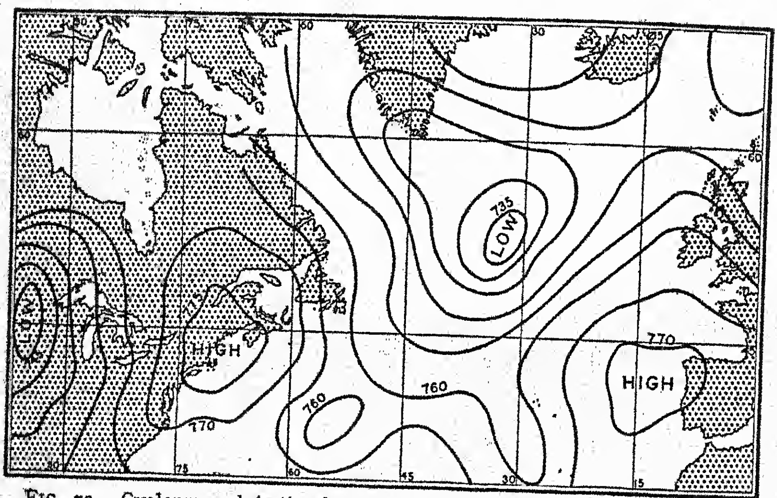


Fig. 73.—Cyclones and Anticyclones over the North Atlantic, March 15.

are known as anticyclones, the low pressure systems as cyclones or depressions. The accompanying wind directions are in accordance with Buys Ballot's Law (p. 104). The chart for March 15 (Fig. 73) shows a well-developed cyclone to the west of the Great Lakes, and another in mid-Atlantic; one anticyclone rests over the maritime provinces of North America, while a second and larger one extends over South-western Europe. On the chart for March 16 (Fig. 74) the same systems can be recognized, but they have shifted their positions, as shown by the dotted lines and the first arrow heads; the American cyclone has moved north-eastwards, the Atlantic cyclone northwards, and the American

anticyclone eastwards, while the European anticyclone has become less well defined. On two subsequent days the systems moved eastwards, as shown by the dotted lines and arrow heads. These charts are typical of the pressure conditions found in both northern and southern hemispheres in the belts of the stormy westerlies; a series of cyclones and anticyclones pass in procession from west to east, altering their shapes, but preserving their identity for days together. Their passage is necessarily accompanied by a series of changes in the wind direction. This point

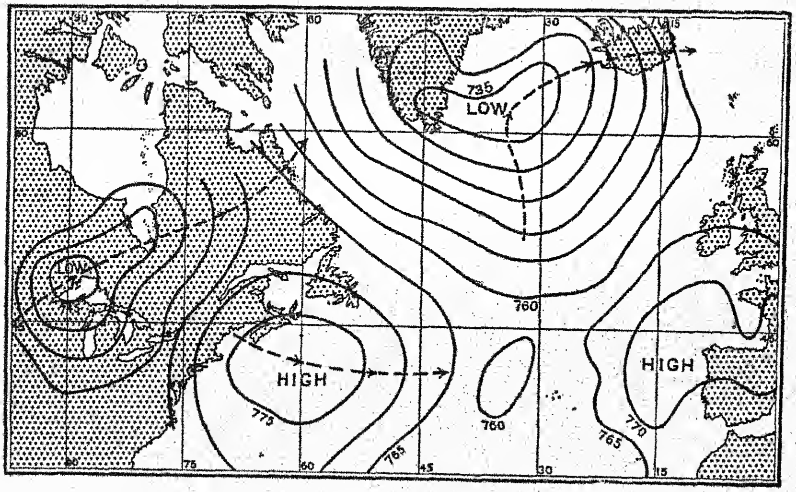


FIG. 74.—Cyclones and Anticyclones over the North Atlantic, March 16.

is illustrated in Fig. 75, which shows a cyclone in the northern hemisphere moving from west to east as the large arrow indicates. A station which lies in the track of the southern portion of the cyclone at first is in that part of the cyclone marked *a*; later it will be in the part marked *b* as the cyclone passes, and still later will be in the part marked *c*. It will, therefore, experience in succession the veering winds shown at *a*, *b*, and *c*, namely, southerly, south-westerly and westerly winds. A station which lies in the track of the centre of the cyclone will have south-easterly winds (*d*), followed by a period of calm as the centre (*e*) of the cyclone passes, and then by a sudden change to north-

westerly winds (*f*). A station lying in the track of the northern portion of the cyclone will have in succession easterly, north-easterly and northerly winds (*g*, *h* and *i*). The wind is *backing*. It is thus possible to tell by the wind changes whether the cyclone is passing to the north or to the south of a station, or directly across it.

Changes of temperature accompany the wind changes, according to the general rule that winds from higher latitudes are cold, those from lower latitudes warm, while winds from the sea are cool in summer, warm in winter, and winds from the land are hot in summer, cold in winter. A cyclone in the southern hemisphere is accompanied by a different series of winds, since the deviation due to the Earth's rotation is towards the left. These changes may be seen by examining Fig. 70.

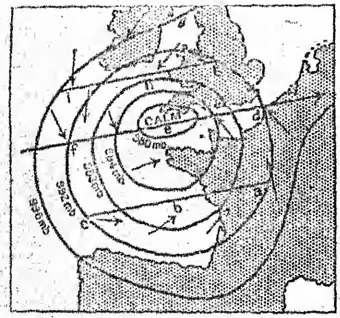


FIG. 75.—Diagram to illustrate the Wind Changes as a Cyclone moves eastwards, in the Northern Hemisphere.

A study of the isobars in Figs. 70 and 75 shows that the barometer falls as the cyclonic depression approaches, and rises once the centre of the depression is passed. It rises as an anticyclone approaches or spreads.

Fig. 74 illustrates an important point of difference between the pressure distribution in a cyclone and an anticyclone respectively. In the former the gradients towards the centre are usually steep, in the latter the gradients away from the centre are slight. Hence the outflowing winds from the high pressure system are light, while the winds associated with the low pressure system are generally strong. Anticyclones are also more sluggish in their movements than cyclones, and sometimes remain in the same position for days and even weeks. The weather changes accompanying cyclones and anticylones will be described in a later section. It will be clear that since (as Figs. 73 and 74 show) the cyclones and anticyclones are constantly moving and changing their shape, the path of an air current during the course of

several hours or days is very complicated. All depends on the relative velocity of the winds as compared with the rate of movement of the system as a whole. Air in the north-west quadrant frequently gets "left behind" and cast out of the system, while air that would blow across the front of a stationary depression actually reaches the calm centre and disappears as a surface current, being deflected upwards. It occurs also that currents from different directions may meet, and then the warmer and lighter one will ascend and flow over the colder and heavier. This usually happens in the front and to the left of the cyclone path.

Prevailing Winds and Mean Temperature.—A comparison of the wind and temperature maps for January and for July respectively shows the importance of the wind direction in higher latitudes. In the January maps it is clear, for example, that the strong, warm, south-westerly winds of the North Atlantic have helped to push the position of the isotherm of 0° C. northwards, while the northerly monsoon of temperate Eastern Asia accounts for the fact that here even on the coast the same isotherm is considerably south of latitude 40° N. Similarly in the July maps, the fact that the western margin of temperate North America has a temperature of less than 20° C. is seen to be partly due to the cool westerly winds from the ocean, while near the eastern margin of Asia the same isotherm bends from 60° N. to 40° N. as it approaches the coast where the monsoon wind is blowing in from the ocean.

Mountain ranges, too, by cutting off the winds from certain quarters, have an important effect upon the temperature. Thus the Alps protect Italy, and the Himalayas protect India from cold northerly winds, while the open central plains of North America allow such winds to sweep the continent from north to south.

For list of Authorities and Books for further reading see bibliography at end of Chapter IX.

Millibars.—The unit of atmospheric pressure now adopted internationally is the millibar. One thousand and thirteen millibars (1013 mb.) is taken as a standard atmosphere *i.e.* as equivalent to a pressure supporting a mercury column of 760 mm. The following are equivalents to the nearest integer:—

1000 mb. = 750 mm. = 29·53 ins.
1013 mb. = 760 mm. = 29·92 ins.
1016 mb. = 762 mm. = 30·00 ins.

CHAPTER VIII

PRECIPITATION

Water Vapour.—Apart from the nitrogen and oxygen, water vapour (which is, of course, a gas and invisible) is the most important constituent of the atmosphere. It is present in very variable quantities, but cannot exceed a certain fixed limit which depends upon the temperature of the air; the higher the temperature, the greater is the quantity of water vapour that air can contain. Air that contains water vapour up to the limit of its capacity is said to be saturated. The process of transformation of liquid water into water vapour is called evaporation; the reverse process is called condensation. Evaporation takes place if the air in the neighbourhood of a water surface is unsaturated, and ceases when the air is saturated. If the saturated air is warmed, its capacity for water vapour is increased, and further evaporation takes place; if the saturated air is cooled, its capacity for water vapour is decreased, and condensation takes place. The graph (Fig. 76) shows the maximum weight of water vapour that a cubic metre of air can contain at various temperatures. It will be noticed that the graph is not a straight line, but forms a curve of increasing steepness; this shows that the capacity is not a simple multiple of the temperature. A numerical example will illustrate this point. A cubic metre of air at 0° C. can contain 5 grms. of water vapour, the same volume at 5° C. can contain 7 grms.; hence by warming the air at this low temperature 5° its capacity is increased by 2 grms. per cubic metre. A cubic metre of air at 30° C. can contain 30 grms., the same volume at 35° can contain 38 grms., hence by warming the air at this higher temperature 5° its capacity is increased by 8 grms. per cubic metre. Air is usually found in the unsaturated condition; for example, if air at

20° C. contains only 12 grms. of water vapour per cubic metre, the graph shows that it is unsaturated, for its capacity is 17 grms. If, however, it is cooled down to 14° C., it becomes saturated, for 12 grms. per cubic metre is the capacity of air at 14° C.; hence any further cooling would cause condensation. The temperature

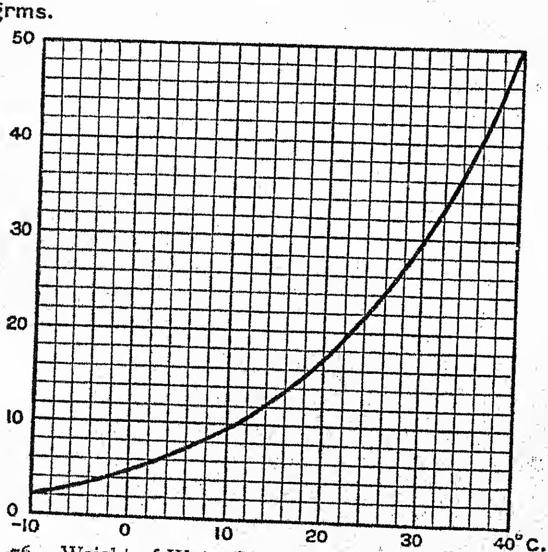


FIG. 76.—Weight of Water Vapour in a Cubic Metre of Air.

to which air must be cooled in order that condensation may begin (in this example 14° C.) is called its "dew-point."

Condensation.—If the air high above the surface of the Earth is cooled below its dew-point, cloud, rain, snow or hail is formed; if the air near the surface is cooled, fog or mist is formed; while if the air actually in contact with the surface is cooled, dew or frost results. It appears, however, that absolutely pure air can be cooled considerably below its dew-point before condensation takes place, and that some nucleus is required around which the water drops are built up. In the lower atmosphere there are innumerable particles of dust and solid matter floating about upon which condensation takes place; the tiny droplets first formed remain suspended in the air as clouds, but each forms a nucleus for further condensation, and when they become too

heavy to be borne up by the air, they fall as rain. It is due to the fact that dust plays a part in condensation that fogs are more frequent in manufacturing towns than elsewhere.

Methods of Cooling.—The air actually in contact with the Earth's surface is cooled at night by conduction, and if it falls below dew-point dew or frost is formed, according as the temperature is above or below freezing point; the air near, but not in contact with the cold surface of the Earth is cooled by radiation. These are direct methods of cooling, to which a third may be added. If air moves horizontally (i.e. as a wind) from a warmer to a cooler place, e.g. from sea to land in winter, or pole-wards from lower to higher latitudes, it will cool directly by conduction and radiation to its surroundings, and cloud or rain may result.

Cooling may also take place owing to the mixing of a warm and a cold air current. Observations of clouds show that at different altitudes the air currents are often moving from different directions, and mixing will take place along the surface of contact of two such currents. A numerical example will show how condensation may result. Suppose that the two currents are saturated, and that the temperature of one is 15° C., and the temperature of the other is 5° C. Each cubic metre of the warmer current contains 13 grms. of water vapour (see the graph in Fig. 76), each cubic metre of the cooler contains 7 grms. If one cubic metre of each be completely mixed, the mean temperature will be 10°, and the total quantity of water vapour 20 grms., that is 10 grms. per cubic metre. But at 10° the capacity of a cubic metre of air is only 9·5 grms., so that 0·5 grm. must be condensed from each cubic metre of the mixture. There is, however, another factor to be considered; whenever condensation takes place, a certain amount of heat (termed latent heat) is set free. Thus, in the example above, immediately condensation commenced some latent heat would be set free and the temperature of the air would be slightly raised; the final temperature would, therefore, be somewhat above 10° and the condensation somewhat less than 0·5 grm.

Of far greater importance than direct cooling, or cooling by mixing, is the cooling which takes place when air expands. This method of cooling has been mentioned on p. 89; when

air is forced upwards the pressure on it is reduced, it expands, and its temperature falls. Ascending air currents are, therefore, usually associated with condensation and precipitation (a fall of rain, snow or hail).

Relief Rains.—A widespread cause of the rising of air and consequent precipitation is the relief of the land, for if a wind blows over rising land, it must itself rise; it then expands and cools, and if its temperature falls below dew-point condensation takes place. Here again, the heat set free during the condensation must be considered, for it makes cooling take place more slowly; this helps to account for the fact that although pure dry air would cool 1° C. for every 100 metres of ascent, the average rate of cooling is 0·6 C. for 100 metres, for air is rarely dry and condensation usually takes place, so that the latent heat reduces the fall of temperature.

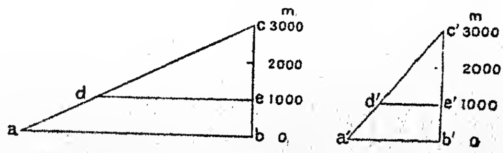


FIG. 77.—Effect of Slope upon Precipitation.

A consideration of the effect of relief upon precipitation shows that the slope of the land is very important. A numerical example will illustrate this. In Fig. 77 *ac* and *a′c′* represent a gently and a steep slope respectively, both *c* and *c′* having an altitude of 3,000 metres. Let it be supposed that an unsaturated air current is forced upwards by these slopes, and let its initial temperature be 15° C., its dew-point 9° C. Then in order to cool through the necessary 6° C. to its dew-point it must ascend 1,000 metres (assuming a cooling of 0·6° C. per 100 m.), thus reaching the points *d* and *d′*, where condensation will begin. During the remaining 2,000 metres of ascent precipitation will take place, while the air cools through a further 12° C., i.e. to −3° C. The graph in Fig. 76 shows that the capacity will be decreased from 9 grms. at 9° to 4 grms. at −3°; this gives a condensation of 5 grms. per cubic metre, which on the gentle slope will be spread over an area of the length *dc*, and on the steep slope will be spread over the much smaller area of length *d′c′*. Hence the steeper the slope the heavier the rainfall. A further point can

be illustrated, by comparing the condensation during the ascent from 1,000 to 1,500 metres, when the temperature falls from 9° to 6°, with that during the ascent from 2,500 to 3,000 metres, when the temperature falls from 0° to −3° C. By reference to Fig. 76 it will be seen that in the former case the condensation is more than 1 grm. per cubic metre, in the latter less than 1 grm.; that is to say, that on the upper slopes the precipitation is less than on the middle slopes where condensation begins. In this example the precipitation near the summit, where the temperature fell below 0° C., would take the form of snow. For the sake of simplicity the average rate of cooling (0·6° C. per 100 m.) has been assumed both before and after condensation, but actually the rate would vary.

Convectional Rains.—Upward air movement and precipitation may occur quite independently of the relief. For example, whenever winds converge on a heated area, they lift the air over that area to a higher level, and are lifted in their turn by the winds following. The air brought to a continent during the summer monsoon, and the air brought to the equatorial hot belt by the trade winds, makes its escape in this way. As the air is lifted it cools, and the heavy rains result which are usually called convectional. In the temperate zones the continents do not form such well-marked low pressure centres in summer, but in hot, still weather local convection currents arise which lead to the formation of thick clouds and heavy rains, sometimes accompanied by thunderstorms. In desert areas where the dry air has a temperature far above the dew-point, convection currents may be set up, but no rainfall can result.

Cyclonic Rains.—Upward air movement is also associated (see p. 111) with the depressions which pass from west to east in the belts of the stormy westerly winds, and hence as these depressions approach, clouds gather and rain is probable. It is usually the case that the air on the pole-ward side and towards the rear of the depression is relatively cold and dry, while that on the equatorial side and towards the front, is relatively warm and moist. As the cyclonic depression moves, some of the warm, moist air flows up over the heavier colder air, and rains result in the front and centre of the system, where the barometer is

falling. The rear of the cyclone, where the barometer is rising, is usually fine. But the heavier cold air may flow beneath the fringe of the warm current, lifting it sharply and causing " clearing showers."

Evaporation.—When air is warmed it becomes unsaturated, and if water is available, evaporation takes place. Thus winds moving equator-wards from higher to lower latitudes become gradually warmed, and are therefore dry, unsaturated winds; the trade winds are an example of this. Just as air is cooled by expansion if it rises, so it is warmed by compression if it descends from higher to lower altitudes. On the windward side of a mountain range the air cools as it rises, and there is probably a heavy rainfall; but on the leeward side the air is descending, and as its temperature rises its saturation capacity increases; it therefore becomes a dry wind, causing the rapid evaporation of any moisture in its path. Similarly the air which settles down in the central regions of high pressure areas or anticyclones becomes warmed by compression, and the winds which blow out from such areas are therefore dry and unsaturated.

Summer and Winter Anticyclones.—The dry condition of the air which takes part in an anticyclonic circulation leads to important results; the sky is clear and cloudless, so that both insolation and radiation proceed very freely. Hence, in summer, when insolation is more effective than radiation, very hot weather is the result; in winter, when radiation is more effective, the same conditions lead to very cold weather. In the central calm area of a winter anticyclone, the lower layers of air may lose so much heat by radiation to the cold surface of the Earth that a fog is the result, especially after previous damp weather.

Distribution of Rainfall.—Since the rainfall of a region depends not only upon the relief, but upon the direction of the prevailing winds, and upon the distribution of high and low pressure systems, it varies considerably with the seasons, and especially with the northward and southward swing of the temperature and pressure belts.

In July.—Fig. 79 shows the mean rainfall for the month of July. The hot equatorial belt of low pressure is marked by

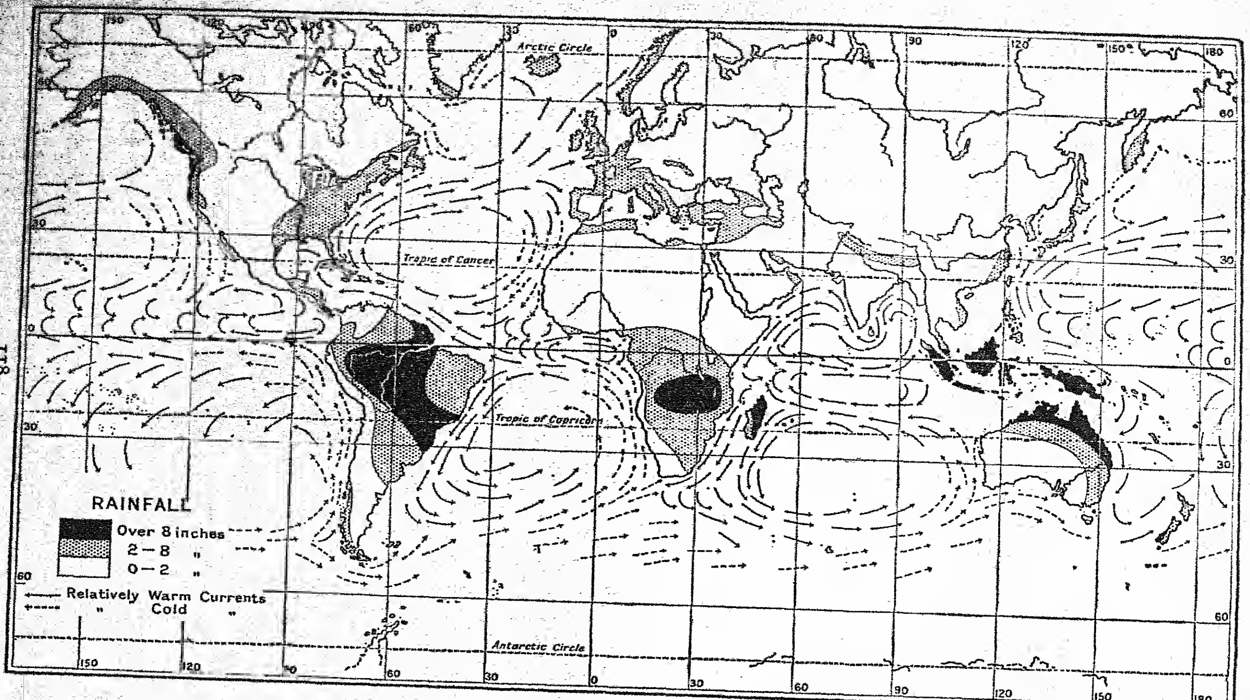


FIG. 78.—Mean Precipitation for January (after Herbertson). Ocean Currents in January (after de Martonne).

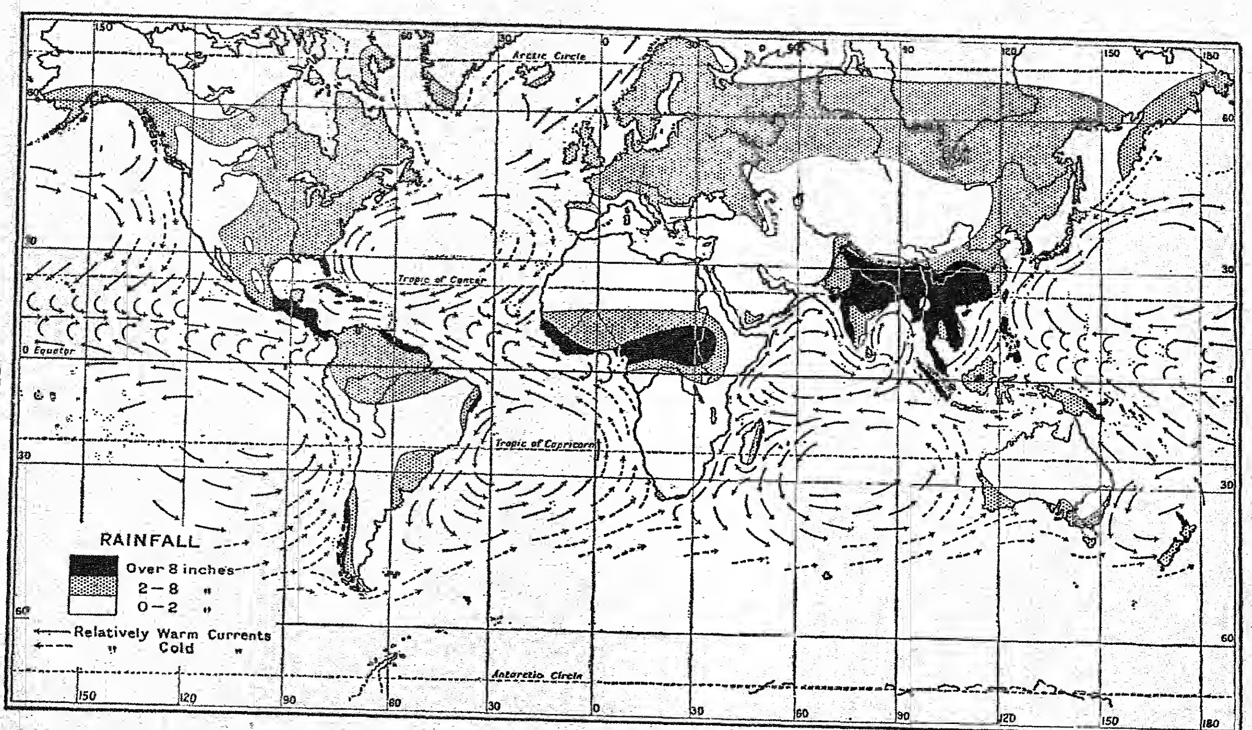


FIG. 79.—Mean Precipitation for July (after Herbertson). Ocean Currents for July (after de Martonne).

heavy convectional rains. This belt includes Central America, the Orinoco basin, the northern part of the Amazon basin, Africa between 0° and 18° N., and the East Indies.

To the north and south of this are two hot dry belts, which mark the areas of higher pressure, and of the dry trade winds which are blowing towards the low pressure belt. The southern dry belt is broken by relief rains, which fall on the east coast of Brazil and of Madagascar; here the south-east trade winds, although blowing towards warmer latitudes, are forced upwards to a considerable altitude and so are cooled below dew-point. The northern dry belt is broken by the convectional rains of the monsoon areas of India, South-east Asia, and the Gulf of Mexico; in the latter the trades are drawn round as easterly winds (see Fig. 72). In India these rains are intensified by the high relief, especially on the Western Ghats, the Himalayas and the mountains of Burma.

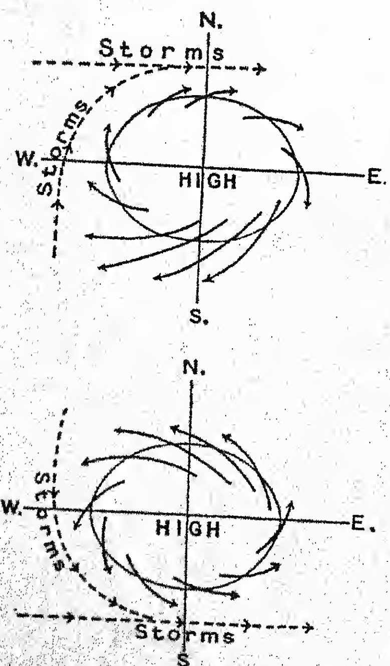


FIG. 80.—Relation of Storm Tracks to the High Pressure Areas of the North and South Atlantic.

Beyond the dry belts lie the regions of relief rains due to the westerly winds, and cyclonic rains caused by the moving cyclones of these belts. The limits of these rains in summer and in winter respectively should be noticed. In the northern hemisphere, where it is summer, they extend as far south as Vancouver Island on the American coast, and Northern Spain on the coast of Europe. In the southern hemisphere, where it is winter, they extend as far north as Valparaiso in South America, and are found also in South-west Africa, South-west Australia, Southern

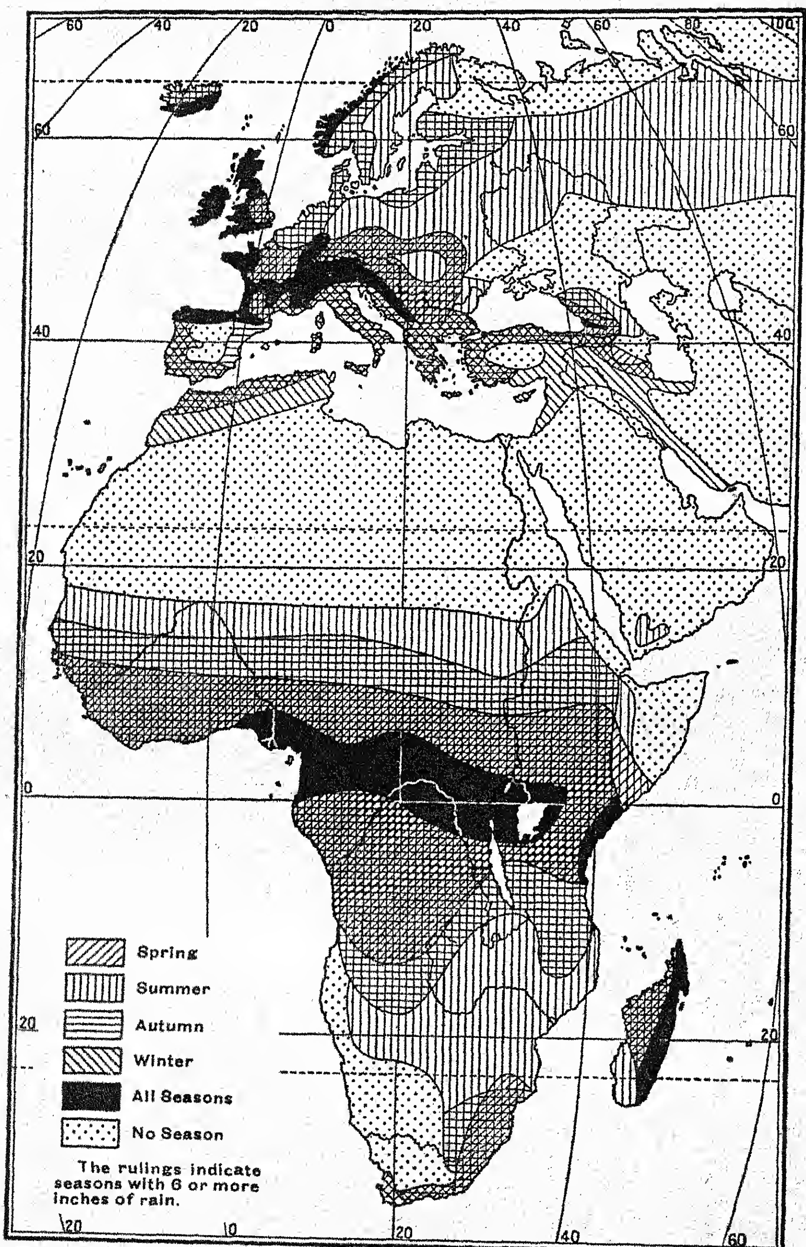


FIG. 81.—Seasonal Distribution of Rainfall, I. (Based on Maps by A. J. Herbertson.)

Australia, Tasmania and New Zealand. In addition to the relief and cyclonic rains, the continental areas in summer have some convectional rains, for in calm, sultry weather local convection currents are set up owing to the unequal heating of the surface of the land.

The rains on the eastern coasts of the continents between the tropics and latitudes 40° N. and S. need special explanation. Those of Eastern Asia are of a monsoon character, but those of the Eastern United States and of the Parana region occur in connexion with the centres of high pressure found over the North and South Atlantic oceans in these latitudes. The winds and also storm tracks connected with these regions of high pressure are shown in Fig. 80. This diagram makes it clear that coasts lying to the west of these centres of high pressure, i.e. the eastern coasts of the continents, are swept by winds moving from lower to higher latitudes, and hence becoming cooler and bringing some rain, while coasts which lie to the east of these centres of high pressure, i.e. the western coasts of the continents, are swept by winds moving towards warmer latitudes, which are therefore dry winds. In addition to this, as is indicated in the diagram, cyclonic storms pass along the western margins of these high pressure systems, in North America up the Mississippi-Ohio valley, in South America down the broad plain of the Parana-Paraguay river, and as a consequence these areas have cyclonic rains.

Two cold areas with little precipitation are found in the polar regions. Their dryness is due to the small capacity for vapour of the cold air, so that a considerable fall of temperature causes only a slight fall of rain or snow.

In January.—Fig. 78 shows the distribution of rainfall in January. The various rain belts have moved southward with the temperature and pressure belts, and in the monsoon areas the conditions have been reversed. The swing of the equatorial rain belt is well marked. Southern and Eastern Asia, with winter monsoons blowing, are dry, while Northern and North-eastern Australia are having summer monsoon rains. It is important to notice that owing to the shape of the eastern coast of Asia, the out-swirling winds from the high pressure region strike the

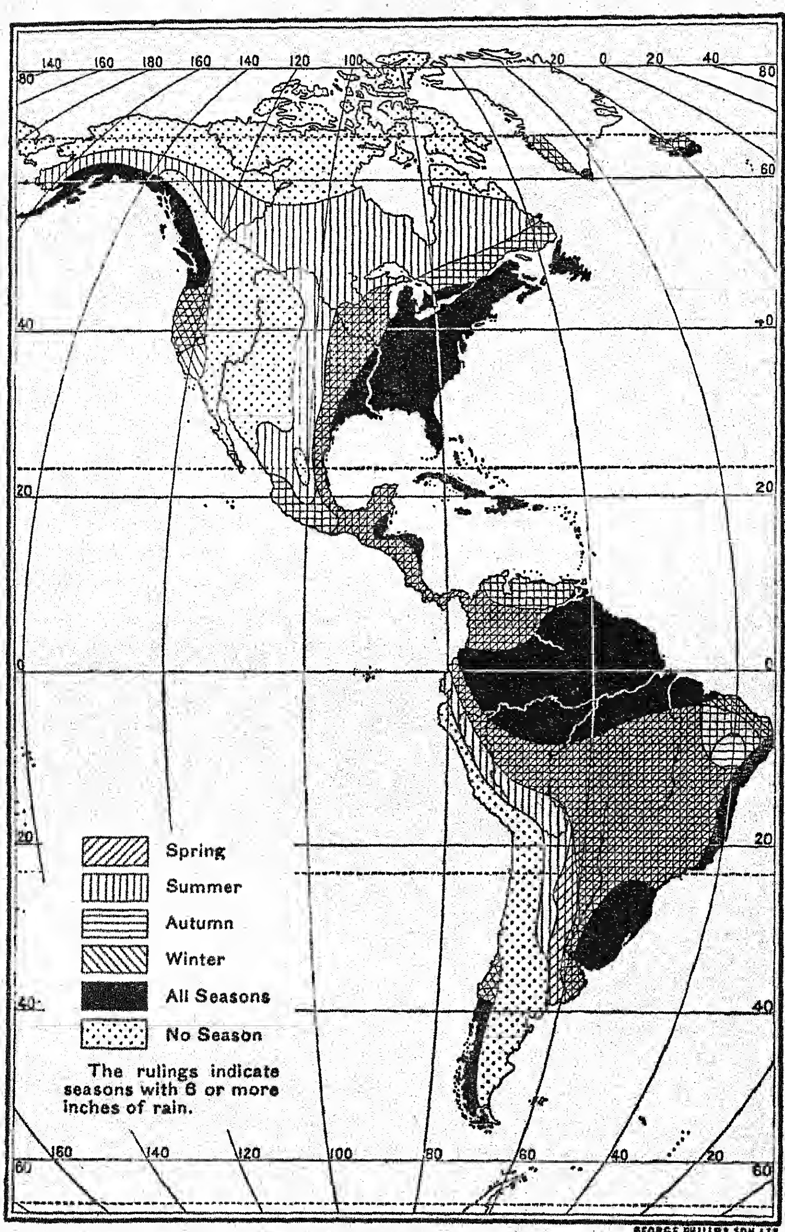


FIG. 82.—Seasonal Distribution of Rainfall, II. (Based on Maps by A. J. Herbertson.)

land again in places after having crossed the enclosed seas, and to bring rain to parts of Japan, Eastern China, and Annam, and similarly to Ceylon.

The relief and cyclonic rains of the westerly wind belt are limited in the northern hemisphere to the coastal regions, for over the continents low temperatures and high pressures usually prevail, accompanied by fine dry weather. At this season these rains extend over California and North Africa, which were dry regions in the summer. In the southern hemisphere their range has been reduced by the southward movement of the belts, and they no longer occur in South Africa or South Australia, while in Chile their limit is lat. 40° S., but they still occur in Tasmania and New Zealand.

The Seasonal Rainfall Maps.—The January and July maps give the key to the more elaborate seasonal maps shown in Figs. 81, 82 and 83. For the sake of convenience it is usual to speak of spring, summer, autumn, and winter when describing seasonal changes of climate; but it must be remembered that these four seasons are characteristic of the temperate zone only, where cool springs, hot summers, warm autumns, and cold winters can be distinguished. In the Frigid Zone there is no hot season, in the Torrid Zone no cold season. The term spring simply denotes the months March–April–May in the northern hemisphere, and September–October–November in the southern hemisphere, and so on for the other seasons.

Africa (Fig. 81), owing to its uniformity and compactness, shows very clearly the seasonal movements of the hot, wet, low pressure belt. Near the equator is a narrow strip which lies all the year in this belt; it forms the centre of it at the equinoxes, its southern margin at the northern summer solstice, and its northern margin at the southern summer solstice. Thus it has two seasons of heavy rains occurring near the equinoxes, and lighter rains during the rest of the year. On either side of this strip are areas which lie in the rain belt for three successive seasons only; the northern one is dry during the northern winter when the rain belt has moved farthest south, the southern one is dry in the southern winter when the rain belt has moved farthest north. Beyond these areas are others with rains in

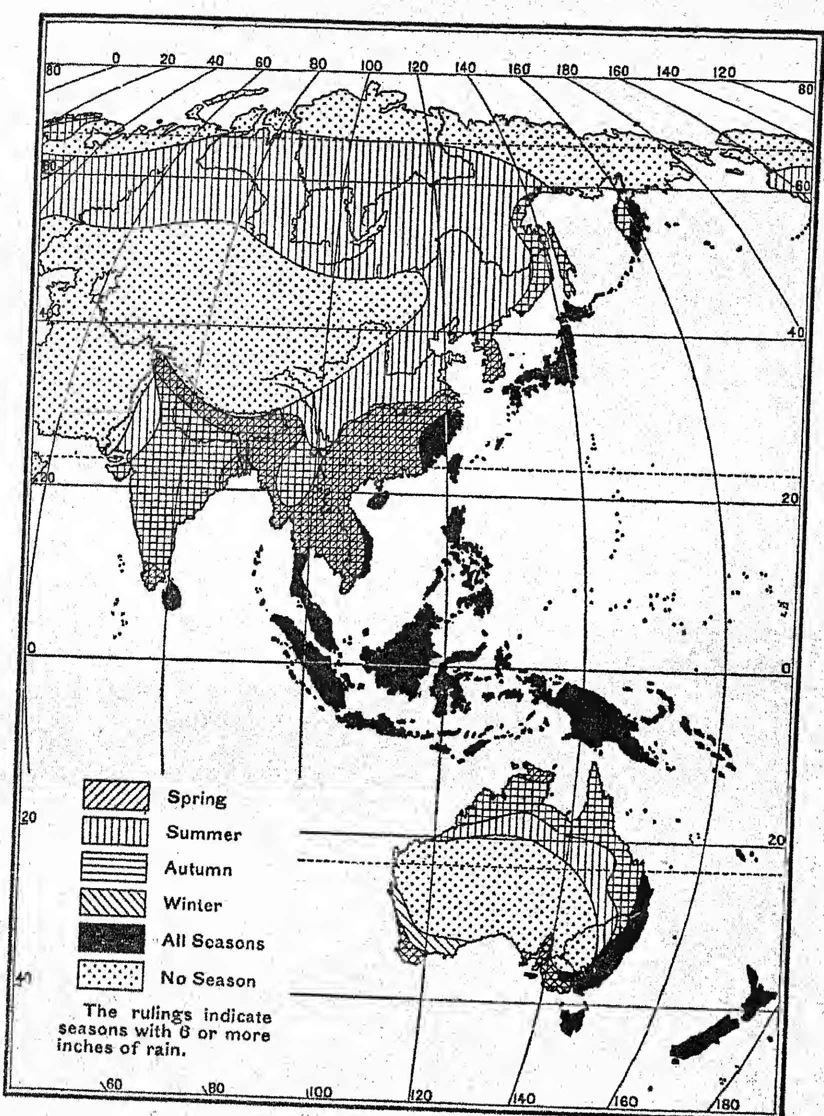


FIG. 83.—Seasonal Distribution of Rainfall, III. (Based on Maps by A. J. Herbertson.)

two successive seasons only, and beyond these again are areas with rain in one season only, namely, the summer when the hot wet belt stretches farthest from the equator. A similar succession of areas having rain for shorter and shorter periods can be traced to the north and to the south of the Amazon area of rain at all seasons (Fig. 82); but the irregular shape of Central America and Mexico on the one hand, and the barrier of the lofty Andes on the other, make the development of the belts less regular than in Africa.

Monsoon conditions are illustrated in India and tropical Australia (Fig. 83). The monsoon rains make their first appearance in late spring at the extreme south of India, and north of Australia. During the summer they extend over the whole of the monsoon area, and during the autumn they gradually withdraw. In India they cease first in the Indus region, which has therefore only summer rains, while in Australia they retreat gradually from the interior, so that a belt which has these rains in summer only is bordered by a belt which has them in both summer and autumn. Whether the winds are drawn across the equator to South-eastern Asia or to Northern Australia, the mountainous islands of the East Indian Archipelago lying in their path are subject to rain.

It should be noticed that it is exceptional to find winter rains within the tropics, where summer rains are practically universal.

The effect of the migrations of the westerly wind belt and its accompanying cyclones is well seen on the eastern shores of the North Atlantic. The extreme western margins of Europe as far south as Galicia in Spain lie all the year in this rainy belt; in autumn it extends down to the north coast of Africa, in winter it covers Algeria and Morocco, in spring it again retreats northward, and in summer almost entirely leaves the Mediterranean lands. A similar succession of seasonal changes may be traced in the western margins of North America, and less completely in Western South America, South-west Africa, and South Australia.

Between the wet westerly wind belts on the one hand and the wet low pressure tropical and monsoon areas on the other, lie the regions which are always dry. These regions reach the coast

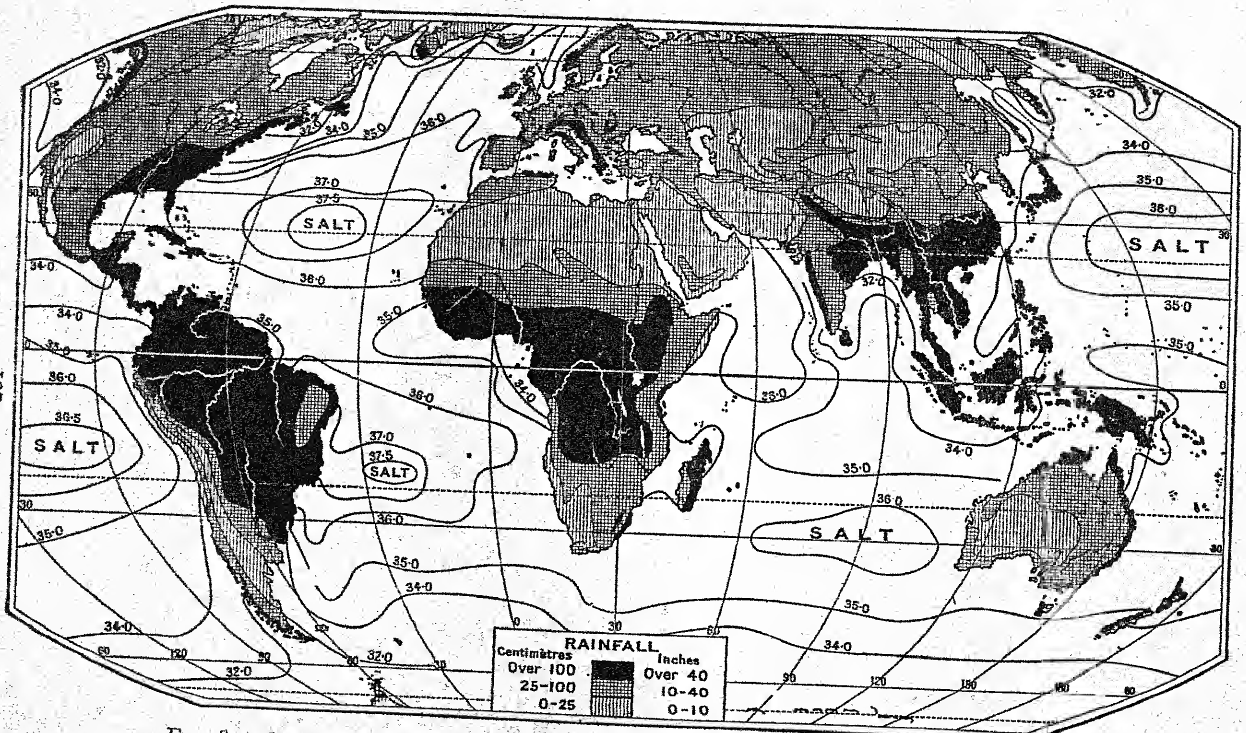


FIG. 84.—Mean Annual Rainfall (after Herbertson and Supan), and Salinity of the Ocean.
[The figures show parts of salt per 1,000.]

on the west of the continents, but are bordered by a wet belt to the east.

Mean Annual Rainfall.—Fig. 84 shows the mean annual rainfall. The three divisions correspond to regions which may be described as well watered (over 40″), moderately watered (over 10″), and deficient in rainfall (under 10″).[1] This map corresponds in its general features to the seasonal rainfall map, and may be represented schematically as in the diagram (Fig. 85). The diagram indicates the contrasts between the west and east coasts of the continents, and the relations between these and the cyclonic or westerly wind belts on the one hand, the trade wind belts on the other. The differences between the ideal conditions shown in the diagram and the actual conditions shown on the map should be observed in the case of each continent separately, and the causes of the differences should be traced to the disturbing influences of the varying distribution of land and water and the local relief.

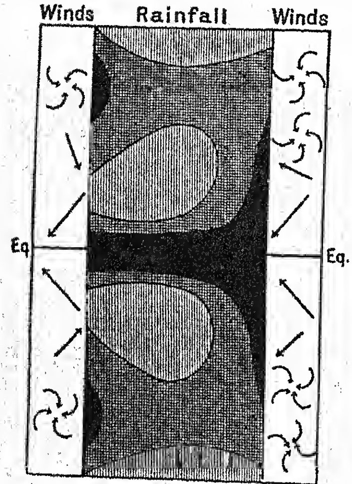


FIG. 85.—Schematic Diagram of Winds and Rainfall. (For Reference to marking see Fig. 84.)

The rule that between the equator and lats. 35° N. and S. east coasts are wetter than west coasts, while in higher latitudes west coasts are the wetter is shown clearly on the diagram; so, too, is the rule that dry areas increase with increasing distance from the sea.

[1] Where the precipitation is in the form of snow, it is calculated on the assumption that about a foot of snow is equivalent to an inch of rain.

For list of Authorities and Books for further reading see bibliography at end of Chapter IX.

CHAPTER IX

STORMS. LOCAL WINDS. CLIMATE REGIONS

Tropical Storms.—The cyclones of the Indian Seas, the typhoons of the China Seas, and the hurricanes of the West Indies, possess all the characteristics of temperate cyclones in an intensified form. The circular shape is more marked, the diameter is smaller (50–300 miles as against 500–1,000 or more), the gradients are steeper, so that the in-flowing air often forms a true whirlwind. There is a small centre of calm, the " eye " of the storm, where the weather is fine and clear; it seems that the in-swirling air escapes upwards in a spiral around a central column of still air, so that on the margin of the calm bright area there are thick clouds and heavy rains. These storms arise at sea, stirring up huge waves, and if they advance landwards these waves may cause serious catastrophes along low-lying shores. Such storms arise when the heat is intense and the air calm, and differ from ordinary convection currents in that the in-flowing winds blow sufficiently steadily to be affected by the Earth's rotation, and so get their swirling motion. Such circular storms do not occur within 10 degrees of the equator, for in such low latitudes the deviation due to the Earth's rotation is too slight to produce them (see p. 101). In the Indian Seas they are most frequent at the change of the monsoons, when there is a period of calm. Elsewhere they occur at the edge of the hot calm belt when it is farthest from the equator, that is to say, in summer.

Tornadoes.—These are violent whirling storms, not more than a few hundred yards in diameter, which sweep forward at the rate of about 25 miles an hour, often rooting up trees and destroying buildings. They occur chiefly in the United States,

between the Rocky Mountains and the Appalachians, and have their origin in the upper atmosphere.

Land and Sea Breezes.—Within the tropics, although the average temperature changes from month to month are very small, the changes during every 24 hours over the land are very marked, although over the sea these also are slight. As a result the land is considerably warmer than the sea during part of the day, and considerably colder during part of the night, so that it becomes a relatively low pressure area by day, and a relatively high pressure area by night. Thus there is an alternation of the systems of air currents shown in Figs. 65 and 66, the surface winds blowing on-shore during the heat of the day, and off-shore during the cold-early morning hours. They are known as land and sea breezes, and may be compared to the monsoons, where the same changes occur every six months instead of every twelve hours. These breezes are confined to the coastal regions and lake-sides of the lands where they occur, and although most characteristic of inter-tropical lands, may be observed also in the temperate zone in summer.

Foehn Winds.—The foehn is a dry hot wind which blows down from the high Alps, usually on the north side. It occurs when the passage over Central Europe of a well-marked cyclone with steep pressure gradients draws a strong current of air across the mountains. As this air rises on the south side of the mountains it expands and cools, and when the dew-point is reached, condensation takes place and rain or snow falls. As it descends on the north side it is compressed, its temperature rises, and its capacity for water vapour increases, so that it becomes a dry wind. The unusually high temperature requires a special explanation, for at first sight it would appear that the fall of temperature as the air rises and expands ought to be equal to the rise of temperature as the air descends and is compressed, so that the final temperature would be no greater than that of an ordinary southerly wind. It must be remembered, however, that whenever condensation takes place latent heat is set free, and hence the heat lost by expansion is partly compensated for by this latent heat, with the result that even before the current begins to descend its temperature is not very low; thus when this relatively warm

air has been further warmed by compression its final temperature is high. According to this reasoning, a foehn-like wind would be expected whenever a moisture-laden current crossed a mountain range; usually, however, an air current which is much warmer than its surroundings loses heat by conduction and radiation, and a special point in the explanation of foehn winds is that they occur when the pressure gradient is steep, so that the current is drawn down too rapidly to lose heat in this manner.

The chinook which blows from the Rocky Mountains down to the Great Plains of North America, and the winds which reach the Canterbury Plains from the New Zealand Alps, are hot dry winds of similar origin to the foehn winds.

Berg Winds, Mistral, Bora.—Winds which blow down from plateaus may be hot and dry, or cold and dry, according to circumstances. If owing to unimpeded insolation the surface of the plateau is hot, the air above it becomes warmed also, and if this air is drawn down into neighbouring lowlands it is further warmed by compression, and so arrives as a hot wind. This is the origin of the hot dry Berg winds experienced round the coasts of South Africa. On the other hand, the wind from a very cold plateau where radiation has proceeded rapidly will still be relatively cold, even after being warmed by compression, as is the case with the mistral, a cold dry wind which rushes down the Rhone Valley from the Central Plateau of France, towards the sunny shores of the Lion Gulf. A very similar wind is the bora, which blows from the Balkan highlands down to the Adriatic Sea. In every case it is the formation of a marked cyclone over the lowlands and seas which causes the down-rush of air.

Sirocco.—When a cyclone passes along the Mediterranean Sea, and the pressure over the Sahara is relatively high, hot dust-laden winds blow out from the desert towards the centre of low pressure. These winds become humid as they cross the sea, and are peculiarly oppressive. They are known in Italy as the sirocco. The khamsin of Egypt, the harmattan of the Sudan, and the "brick-fielder" of Australia, are dry winds of a similar character, and probably have a similar origin.

CLIMATE REGIONS

The various elements of climate—insolation, temperature, pressure, winds, and rainfall—have now been considered separately with regard to their distribution through the year and over the Globe. Roughly speaking, similar combinations of elements reappear in similarly situated parts of the Globe, so that if the different continents are divided into climatic regions the same type recurs several times. Since climatic changes are never abrupt, the characteristics of one region cannot be sharply separated from those of the next, the transition from one to another is gradual, and the actual boundary lines must be drawn arbitrarily. In different parts of the world different elements are prominent, for example, in one region the outstanding characteristic may be the heavy summer rains, in another the severe winters, in another uniformity of temperature, and so on, so that the boundary line may be in one case an isohyet (i.e. a line of equal rainfall), in another an isotherm, in another a line of equal range of temperature.

The differences of insolation according to latitude, and the consequent division of the world into climate zones, have already been pointed out (see p. 85), and must be borne in mind, but the exact boundaries of these divisions by parallels of latitude cannot be followed. Two characteristics of the Frigid Zone are the cold winter and cool summer, and regions which have a temperature of under 0° C. in the coldest and under 10° C. in the warmest month may be taken as fulfilling these conditions. A characteristic of the Temperate Zone is the seasonal contrasts of temperature, and this must be expressed in the climate regions. The Torrid Zone is always hot, and this condition is also fulfilled by such regions beyond the tropics as have a mean annual temperature above 20° C., as, for example, the northern plains of India. It is clear that the ways of marking off the regions are almost infinite, and the divisions are only valuable in so far as they emphasize certain important climatic features which constantly repeat themselves, so that the regions may be grouped into types.

The map of climate regions (Fig. 86) should be compared

with the preceding maps dealing with climate. The scale of the map allows only the larger regions to be shown. The boundary lines divide off the various regions, and the letters indicate the type to which the regions belong. It will be seen that areas bearing the same letter, although presenting features in common, show also some points of contrast.

A. This type includes the equatorial belts of South America and Africa, and the inter-tropical islands, which have rain at all seasons and uniformly high temperatures.

B. This includes the tropical regions which have their chief rains in summer, either owing to monsoon winds or to the seasonal swing of the hot wet belt, and have a relatively dry season at the winter solstice.

C. This includes the great tropical desert areas of North Africa, Arabia, and Australia, where very high temperatures emphasize the arid conditions.

D. These are the extra-tropical arid regions, where the rainfall at no season exceeds six inches, and is often considerably less. Regions are included which lie within the tropics, but where owing to the altitude the mean annual temperature is less than 20° C. The daily temperature range in these regions is great, and the winters are often severe.

E. This warm temperate type of region is found on the eastern margins of the continents, just beyond the tropics. The rainfall occurs at all seasons, or at all but the winter season, and the winters are not severe.

F. The Mediterranean is the most extensive of the regions of this type; the areas are characterized by summer droughts, as they lie outside the range of the westerly winds during summer. They are under oceanic influences, so that the winters are mild, and the summers not excessively hot.

G. This type of region is found on the western shores of the continents, in higher latitudes than the last mentioned; the rain occurs at all seasons, or at three, including summer. The islands of Tasmania and New Zealand are included under this type, as the features are essentially determined by the proximity of the oceans and the influence of the westerly winds, to which are due the moderate temperate range, plentiful rainfall, and mild winters.

H. This is the cool temperate continental type of region, which includes both the inland areas and eastern margins of the northern land-masses in high latitudes. The range of temperature is considerable, and in the regions far from oceanic influences very great indeed. The winters are very cold or cold, the summers warm or hot. The rainfall is chiefly in the summer, rain at other seasons only occurring near the eastern coasts.

J. This type of region is never warm, the summers are cool, the winters cold, and the precipitation small.

K. This type includes the mountainous regions where the characteristic of the relief is the alternation of ridge and valley, so that many varieties of climate are embraced within a small area. The temperature varies with altitude and with exposure, the rainfall or snowfall with altitude and wind direction. Warm sunny valleys are overlooked by snow-capped peaks. Only the more extensive mountain regions are shown, and wherever the ridges enclose wide basins or plateaus, as in the case of parts of the Western Cordilleras of the two Americas, and in Central Asia, the climate of these basins or plateaus (usually of the arid type) has been taken as characteristic of the region, rather than that of the neighbouring ridges and valleys, and the region has, therefore, been included in one of the other types (usually that marked D).

Within all the regions shown on the map contrasts occur owing to differences of altitude; in general it may be stated that the higher portions have somewhat heavier or more frequent rains, and lower temperatures than the surrounding areas.

AUTHORITIES AND BOOKS FOR FURTHER READING.

J. G. Bartholomew, A. J. Herbertson and A. Buchan: *Atlas of Meteorology* (Edinburgh: Bartholomew).
D. Brunt: *Weather Study* (Nelson).
D. Brunt: *Physical and Dynamical Meteorology* (Cambridge Press).
V. C. Finch and G. T. Trewartha: *Elements of Geography* (New York: McGraw-Hill).
Obst-Supan: *Grundzüge der physischen Erdkunde* (Leipzig: Veit).
R. de C. Ward: *Climate, in its Relation to Man* (Putnam's Sons).
E. de Martonne: *Traité de Géographie Physique* (Paris: Colin).
A. Miller: *Climatology* (Methuen).
J. Kendrew: *Climates of the Continents* (Oxford Press).
T. A. Blair: *Weather Elements* (New York: Prentice-Hall).
Meteorological Office: *The Daily Weather Report.*

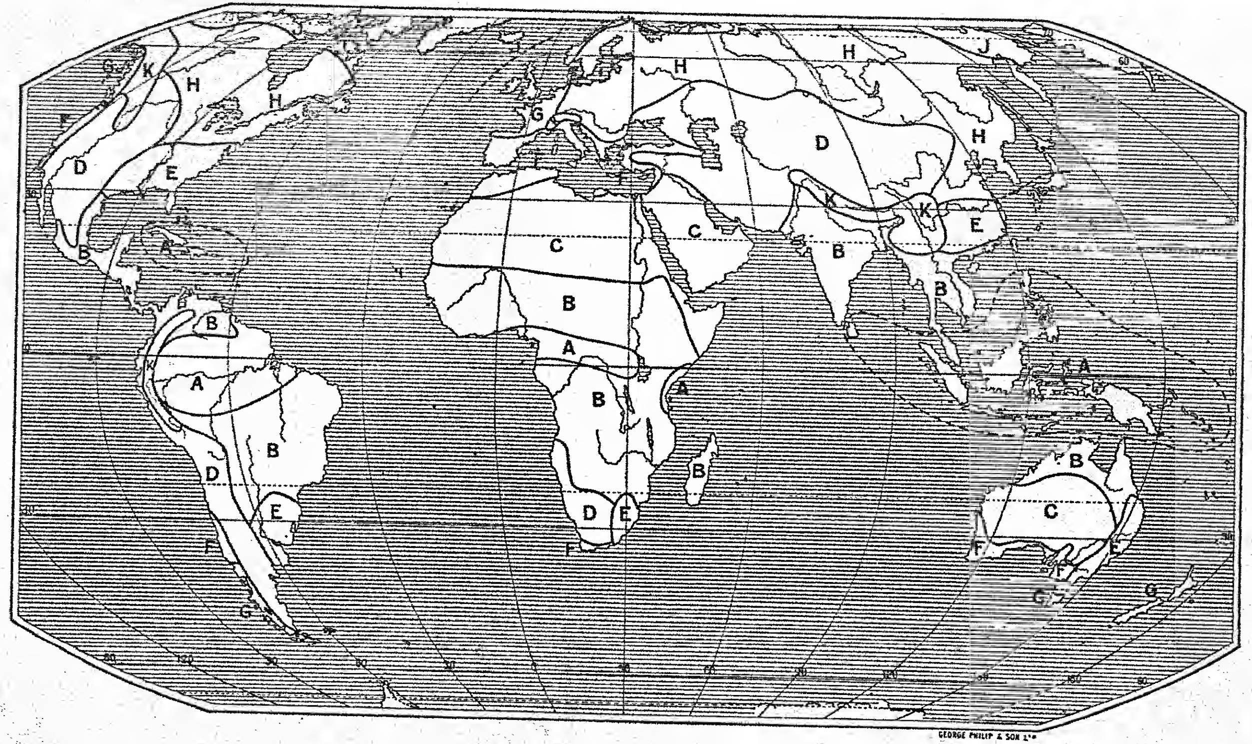


FIG. 86.—Climate Regions and Types.

CHAPTER X

THE OCEANS

Salinity.—Sea water differs from river water in two particulars: it contains a much larger percentage of salts in solution, and it contains the various salts in totally different proportions. In sea water chlorides take the leading part, sodium chloride (common salt) being the chief of these, while in river water the carbonates are the most important; great quantities of carbonates are, however, found in the sea in the solid form, as the shells and hard skeletons of various marine organisms. The result of many analyses gives the mean weight of salts dissolved in 1,000 parts of sea water as 35. This is usually expressed by saying that the salinity is 35 per thousand, or 35 ‰.

The distribution of salinity over the oceans is shown in Fig. 84. The lowest readings are under 32 ‰, the highest over 37·5 ‰. The variations from the normal value, 35 ‰, are due either to the removal of pure water by evaporation, whereby the proportion of salt to water is increased, or to the addition of fresh water by rain, melting ice, or rivers, whereby the proportion of salt to water is diminished. The general arrangement of the lines of equal salinity (isohalines) is somewhat similar to that of the isobars in October (see Fig. 67). A belt near the equator of relatively low salinity is bordered by areas of higher salinity (marked SALT) while beyond these areas the salinity diminishes pole-wards. The resemblance of the maps is not accidental, the areas of high salinity lie in the trade wind belts, and, as has already been pointed out (see p. 117), these winds are dry and cause rapid evaporation, so that the surface waters become salt. In the equatorial belt the heavy rains explain the decreased salinity, while in the higher latitudes also the rainfall

is greater and the evaporation less than in the trade-wind belts. The great volume of water brought down by the Niger and the Congo accounts for the low salinity of the Gulf of Guinea, and a similar area of fresher water might be looked for round the mouth of the great Amazon, but here a strong ocean current sweeps the river water away.

In partially enclosed seas the salinity depends upon the relation between the evaporation on the one hand and the rainfall and the quantity of water brought down by rivers on the other. In the Baltic Sea, for example, which is almost entirely cut off from the ocean, the heavy rain and snow-fall, together with the water brought by the great German and Russian rivers, reduce the salinity to less than 12 ‰. Similarly in the Black Sea the waters are comparatively fresh (15–18 ‰). The Mediterranean and the Red Sea show very different conditions. Here the low rainfall, the great evaporation, and the absence of large rivers, make the waters very salt, in the Mediterranean over 37 ‰, and in the Red Sea over 40 ‰. Seas and lakes without any outlet to the ocean have an even higher salinity, for they contain an accumulation of all the salts brought down by rivers since their formation. Thus the salinity of the Great Salt Lake of Utah is 220 ‰; that of the Dead Sea 250 ‰. When such lakes and seas disappear, they leave behind vast deposits of rock salt and other salts.

Waves.—The surface of the ocean is never at rest. Under the disturbing influence of the wind, waves are formed, which move forward in the direction of the wind. But it must be clearly understood that although there is a movement or onward progress of the form or shape of the wave, there is no actual transport of the water.[1] The latter merely rises and sinks in the same place, as may be seen by observing an object floating on a surface disturbed by waves; the object rises and falls, but comes no nearer to the observer, although wave after wave rolls towards him. Even when the wind drops, the movement of the water does not cease, but long, low, flat-topped waves, known as a swell, roll across the surface. The water down to a considerable depth

[1] The explanation of this is somewhat difficult, and is placed in Appendix A at the end of this chapter.

takes part in the movement of oscillation, which produces at the surface the alternation of wave crest and trough. When the waves reach shallower water, the friction of the sea bottom checks the motion of the under part of the wave. This has the effect of turning the waves, whatever their initial direction, until they are parallel to the shore. Fig. 87 illustrates this alteration of direction. The lines *a b*, *a′ b′*, etc., are successive positions of the crest of a wave, and the depth of the water is shown in fathoms. The end *b* is in shallower water than the end *a*, hence its velocity

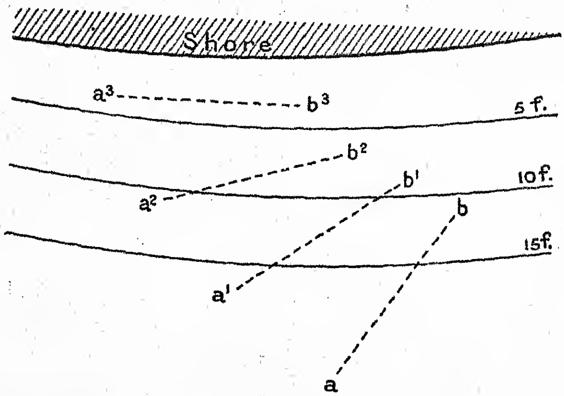


FIG. 87.—Alteration of Wave Direction.

is checked to a greater extent by friction with the bottom, and it progresses more slowly than *a*; *b* therefore lags behind until both ends are in water of equal depth, that is to say, until the wave is parallel to the shore. Meanwhile, the under half of the wave is checked more and more, while the upper half continues its progress, until at last it breaks, and curling over hurls itself forward on to the beach. The most powerful breakers in the world are those of the Guinea Coast, where there is a constant westerly swell from the South Atlantic.

Although the wave movement extends theoretically to a great depth, its force rapidly diminishes, and at 100 fathoms (200 metres) the sand is barely stirred, however violently the surface is agitated.

Tides.—Round the margins of the oceans, the level of the sea is not constant; it rises and falls, alternately covering and leaving bare the sand and rocks around the shores. The times of high

water or high tide follow one another quite regularly at an interval of about 12½ hours, but the high water mark and low water mark vary from day to day. The difference between the two, called the amplitude of the tides, gets greater and greater, until it reaches a maximum value, then it gets gradually less and passes through a minimum value, returns to the maximum, and so on. For example: On December 9, 1904, at North Shields, the readings above zero at high and low tide were 14 feet 2 inches and 0 feet 0 inches respectively, giving an amplitude of 14 feet 2 inches; on December 16 they were 10 feet 10 inches and 4 feet 0 inches respectively, giving an amplitude of 6 feet 10 inches; on December 24 they were again 14 feet 2 inches and 0 feet 0 inches. The tides of great amplitude, when both rise and fall are great, are called spring tides; the tides of small amplitude, when both rise and fall are slight, are called neap tides. Each occurs twice a month, and this fact, added to the fact that the time elapsing between successive high tides is nearly 12½ hours, i.e. half the time elapsing between the rising of the Moon on successive days, points to the Moon as the chief cause of the tides, and this is actually the case. The result of the gravitational attraction between the Earth and the Moon is that there is a tide-raising force acting upon the oceans.[1] Fig. 88 shows where high and low tides occur. According to theory, the tide-raising force is greatest at A where the Moon is in the zenith, and at B where the Moon is in the nadir,[2] while it is least on the circle passing through NL'S where the Moon is on the horizon. There is, therefore, high tide at A and B and low tide at N, C and S.

As the Earth rotates, the Moon also travels along its orbit around the Earth in the same direction as the Earth's rotation. Hence it takes rather longer than the time of a complete rotation, namely, a period of 24 hours 52 minutes, for any meridian, e.g. NAS, to pass from a position under the Moon and return to the same position again. This period of 24 hours 52 minutes is known as a lunar day. Consider any point on the equator: it

[1] An explanation of the cause of the tides implies some knowledge of dynamics, and is therefore placed in Appendix B at the end of this chapter.

[2] The nadir is the point directly under foot, and therefore opposite the zenith.

would have high tide when at B, and, as the earth rotated, low tide when at C, and high tide again at A, after the lapse of $12\frac{1}{2}$ hours, or half a lunar day. There would be low tide again at the point corresponding to C on the opposite side of the globe, and high tide again at A at the completion of the lunar day. Similarly, a point at latitude L will have two high and two low tides, although since the altitude of the Moon is less at L than at A, the high tide is not so marked.

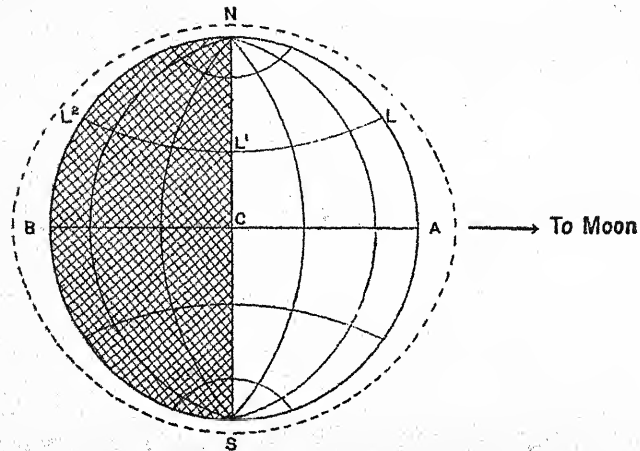


FIG. 88.—Lunar Tides.

The explanation of spring and neap tides depends upon the fact that the gravitational attraction between the Earth and the Sun also results in a tide-raising force, greatest at the points where the Sun is in the zenith and in the nadir respectively. Owing to the enormous distance of the Sun from the Earth, the amplitude of the solar tides is much less than that of the lunar tides. Fig. 89 shows the relative positions of Earth, Moon and Sun during a month. In I the Sun and Moon are in the zenith together, so that the solar and lunar high tides and their two low tides coincide and reinforce one another; this gives the spring tides, which have a great amplitude. In II the solar high tides coincide with and partly neutralize the lunar low tides, and vice versâ, so that the tidal amplitude is small, giving neap tides. In

III, when the Sun is in the zenith and the Moon in the nadir, the tides again coincide, giving spring tides; in IV they are again in opposition, giving neap tides. A comparison of this diagram with that showing the phases of the Moon (Fig. 22) shows that spring tides occur at the times of new and full Moon, and neap tides at the first and last quarters.

The tides may be looked upon as two great waves sweeping round the globe, their crests 180 degrees apart, their height from crest to trough depending upon the position of the moon. It is clear, however, that owing to the irregular shape and depth of

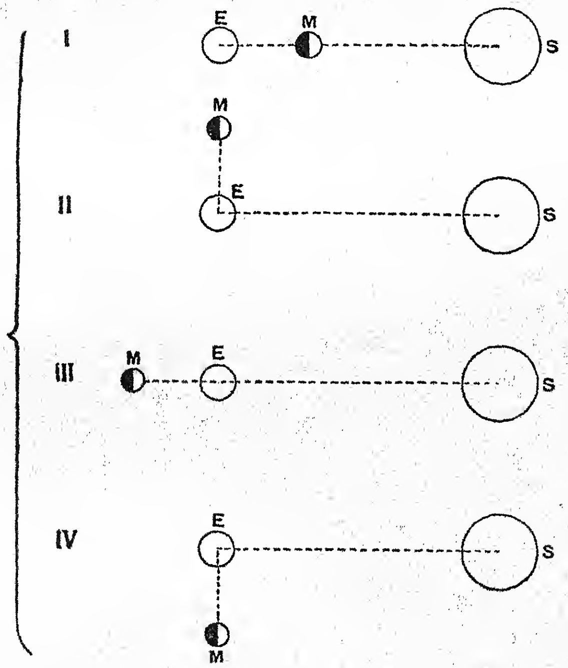


Fig. 89.—Spring and Neap Tides.

the oceans and the obstructing land masses, the actual tidal waves must differ very greatly from those which have just been considered theoretically. In the open ocean the amplitude of the rise and fall of the tides is not more than 1 or 2 feet, but round the continents where the tidal waves sweep into the shallow or

narrow seas, the waters are heaped up and the amplitude is more nearly 20 feet, or even more. In narrowing estuaries, where the wave becomes more and more confined, the rise may be as much as 50 feet, as at Bristol, and in extreme cases where the advancing wave is met by a river current, it may rush up the river like a wall of water several feet high ; such a wave is called a bore and occurs in the Seine, Severn, Yangtse-kiang, and many other rivers.

Tidal Currents.—The progress of the tidal waves in the narrow and shallow seas is accompanied by strong currents (see Appendix C) which at certain periods flow in the direction of the advance of the wave (flood currents) and at certain periods are reversed (ebb currents). These tidal currents are of great importance, especially to ports situated on estuaries ; twice a day the tides provide deep water for shipping, and the vessels can ascend the estuary on the flood current, and descend it with the ebb current. Then, too, the currents assist in sweeping rock waste from the mouths of rivers, and from straits and other channels ; but, on the other hand, they may pile the waste into dangerous shoals and sand banks, and where they rush through narrow channels or among islands they may cause dangerously strong currents and eddies. Such is the origin of " races " and whirlpools.

Ocean Currents.—The tidal currents which are so marked in the shallow seas must be distinguished from ocean currents, which are set up mainly by the wind. When a steady wind blows over a water surface, the friction between the moving air and the water eventually sets the latter in motion also. The velocity of the water is much less, however, than that of the wind, owing to its greater weight. The currents do not exactly follow the wind direction, as they are necessarily turned aside by the land masses, and are also slightly deflected owing to the Earth's rotation (cf. p. 102).

Fig. 90 shows an ideal set of currents set up in an ocean bordered by land masses, the ocean being land-locked to the north at about 65° N., and open south of 35° S. The diagram represents schematically the Pacific and Atlantic Oceans, the latter being partially enclosed to the north. The steady trade winds may be looked upon as starting the circulation of the water. They set up westerly currents, AB and A'B', between the tropics and the

equator. (Currents are named according to the direction *towards* which they flow.) The westerly currents are known as the north and south equatorial currents; on approaching the land at B and B′, they divide north and south. The main branches move

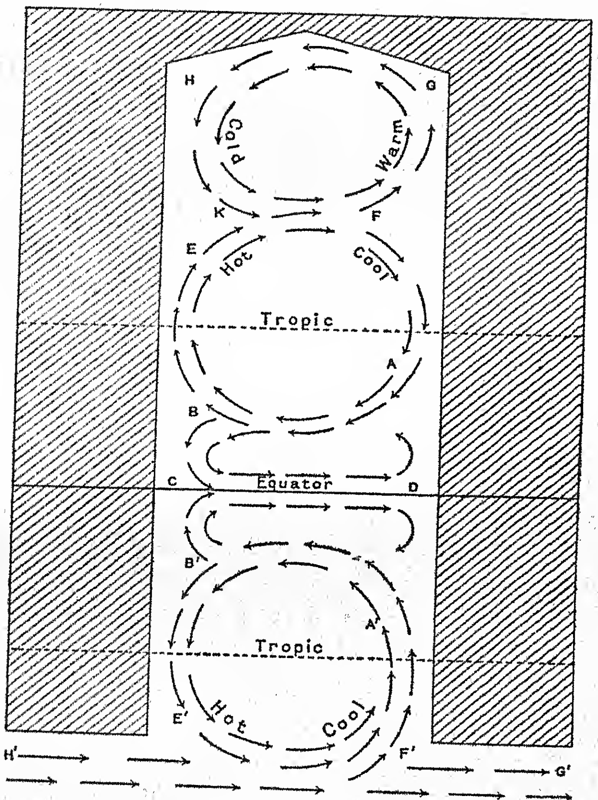


FIG. 90.—Schematic Diagram of Ocean Currents. [The terms "Warm" and "Cool" refer to the waters as compared with the air of the regions into which they flow.]

pole-wards along the margin of the continents, but a part of the water forms an easterly counter-current, CD, along the equator. The pole-ward moving currents, BE and B′E′, partly deflected by the Earth's rotation, partly impelled by the westerly winds, gradually bend away from the land, and move eastwards,

Reaching the opposite land mass these currents again divide at F and F′, a part bending equator-wards and finally being caught again into the trade-wind belt AB and A′B′. The remaining part behaves differently in the two hemispheres, owing to the ocean being closed in the one, and open in the other; thus in the north the water makes a circuit, FGH, close to the shore, while in the south it moves steadily eastwards, H′G′, under the influence of the westerly winds. The most important currents are the clock-wise circulation, BEA, about the Tropic in the northern hemisphere, and the counter clock-wise circulation, B′E′A′, in the southern hemisphere. The temperature of the currents depends upon the region from which they are flowing. Those moving from lower to higher latitudes are first hot, as BE, then merely warm, as FG; those moving from higher to lower latitudes are cold, as HK, or cool, as FA. Comparing the maps (Figs. 78 and 79) with this diagram, it is seen that in the Atlantic, Pacific and South Indian Oceans all its main features are reproduced.

In the Indian Seas the north-east monsoon drives the waters westward in winter, from Burma along the coast of India and Iran towards Somaliland, and here the waters turn south and (with part of the south equatorial current) form a strong equatorial counter-current. In summer the south-west monsoon drives the waters eastward along the coast from Somaliland to Further India where they sweep round and join the south equatorial current. In the China Seas also the currents change with the monsoon. In the Atlantic Ocean the current started by the south-east trades (the south equatorial current) is divided by the wedge-shaped coast of Brazil, and sends a branch northwards past the Amazon mouth to join the north equatorial current. The combined current again divides, part passing to the east of the West Indian Islands, and part circulating through the Gulf of Mexico. The latter branch issues through the Strait of Florida as the well-known Gulf Stream, which has a velocity of three nautical miles an hour; as it moves northward and crosses the Atlantic to Europe its temperature diminishes, and its velocity falls to less than a mile an hour. Here it is known as the Gulf Stream Drift or North Atlantic Drift; part passes on through the Norway Sea, and it can even be traced in the Arctic

Ocean. The corresponding warm current of the Pacific Ocean is the Kuro Shiwo, which flows past Japan. Among the important cold or cool currents are those flowing past the coasts of Labrador, Peru, and South-west Africa (the Benguela current).

A comparison of the January and July maps shows a slight shifting in latitude of the currents in the tropical seas, which corresponds with the shifting of the trade-wind belts. In a small portion of the still waters enclosed by the clock-wise circulation of the N. Atlantic, seaweed has accumulated, and the area is known as the Sargasso Sea.

Ocean currents are important, partly because of their influence on sailing and steamship routes, but chiefly on account of their indirect influence on climate. The effect on the air temperature may be seen by comparing Figs. 78 and 61. The pôle-ward bend of the winter isotherms over the North Atlantic is due to the fact that the prevailing south-westerly winds come from lower, i.e. warmer, latitudes, but the high temperature of these winds is maintained by the warm ocean drift over which they blow. It is only when the prevailing winds are on-shore that the temperature of the ocean affects that of the land; for example, the cool currents along the western margins of the continents, although they cause an equator-ward bend of the isotherms over the oceans, do little to mitigate the high land temperatures, for the prevailing winds blow from the land to the sea.

Floating Ice.—The freezing point of water is lowered by the addition of soluble salts, hence sea water does not freeze until the temperature falls to $-2°$ C., or about $28°$ F. The ice when formed protects the water beneath from further cooling, so that freezing does not take place to any greater depth than two or three yards. The sheet of ice is called field-ice; it may remain unmelted for many years, being gradually broken up and tossed about by storms until it becomes piled into irregular masses known as pack-ice. In the land-locked Arctic Seas there are vast accumulations of pack-ice, which are a source of danger to navigators and explorers. In the open Antarctic waters the field-ice breaks up and floats away unhindered.

Icebergs are floating masses of fresh-water ice which have been broken off from the ends of such glaciers as come right down

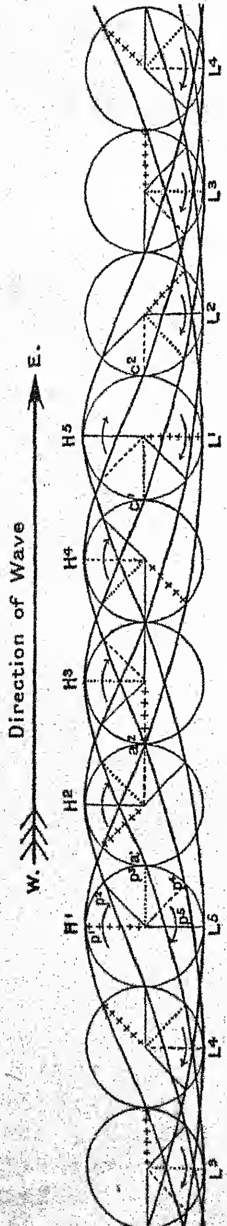


Fig. 91 (a).—Motion of Particles in an Advancing Wave.

to the sea. The chief sources of icebergs are the great ice-sheets which cover Greenland and the Antarctic continent. The Greenland icebergs are carried south by the Labrador current, and have as a rule melted before they pass Newfoundland; they have the effect of greatly chilling the air, and the mixture of the chilled air above the Labrador Current with the warm and moist air above the Gulf Stream leads to the dense fogs of the Newfoundland Banks. The Antarctic icebergs are flat-topped and of enormous size, sometimes over forty miles long and projecting three or four hundred feet above the surface of the water.

Icebergs, besides lowering the air temperature, are a great menace to shipping; hence the warm drifts which flow round the shores of N.W. Europe are of additional importance because they keep the seas free from floating ice. In some years icebergs are exceptionally numerous, and are met with far beyond their usual limits; as a result the weather of neighbouring lands may be abnormally cold and dry, for the winds are chilled by the ice and cannot take up their normal content of water vapour.

Temperature of the Oceans.—The surface temperature of the oceans is usually a few degrees higher than that of the air above, but since the heat of the sun is partly reflected back and partly used up in evaporating the water, the temperature falls very rapidly below the surface, and below 2,000 fathoms uniformly low temperatures only a few degrees above

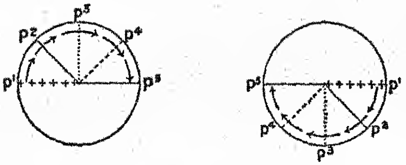


FIG. 91 (*b*) and (*c*).—Direction of Movement of Particles in their Orbits.

freezing point are met with in all oceans, whatever the surface temperature. In regions with prevailing off-shore winds, such as the west coasts of tropical lands, the surface waters of the ocean are blown sea-wards, and the cold bottom water wells up to take their place, thus considerably lowering the surface and air temperatures.

APPENDIX A

Waves.—The particles taking part in a wave movement really move in small circular or elliptical orbits.

Fig. 91 (*a*) shows diagrammatically a wave advancing from west to east, H^1 H^2 H^3 H^4 H^5 being the successive positions of the crest, and L^1 L^2 L^3 L^4 L^5 the positions of the troughs on either side of the corresponding crest. The circles show the orbits in which the water particles move; for example, as the crest advances from H^1 to H^5, the particle p^1, originally on the crest H^1, moves to p^2 while the crest moves to H^2, to p^3 and p^4 while the crest moves to H^3 and H^4, and then (at p^5) lies exactly in the trough L^5 of the wave whose crest is H^5. Similarly, a particle lying at L^1 in the trough of the wave whose crest is H^1, can be

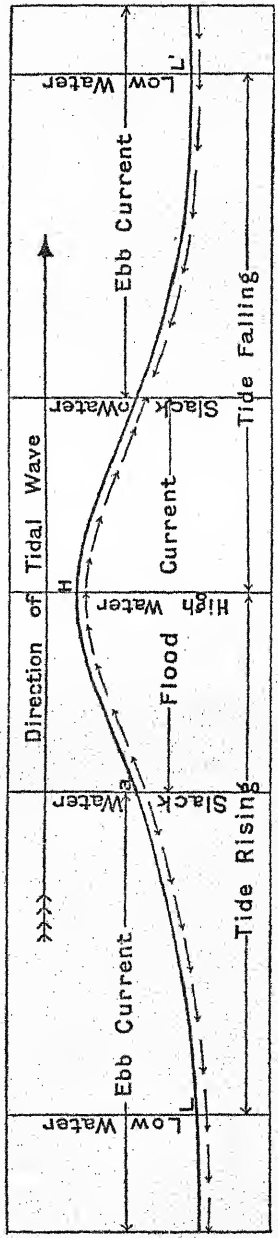


FIG. 91 (*d*).—Relation of Tidal Currents and Tidal Wave.

traced round a semicircle until it lies on the crest H^5. Figs. 91 (*b*) and (*c*) show the direction of movement of the particles in the upper and lower parts of their orbits respectively. In the upper part the direction, as shown by the arrows, is from west to east, i.e. the same as that of the advancing wave; in the lower part it is in the opposite direction to the wave, i.e. from east to west. In Fig. 91 (*a*) these directions can be traced in the complete wave $L^3H^3L^3$: the particles lying in the part $a^1H^3c^1$ are all moving in the upper half of their orbits, i.e eastwards, as in diagram (*b*); the particles lying in L^3a^1, and c^1L^3 are moving in the lower half of their orbits, i.e. westwards, as in diagram (*c*). This is shown more clearly in Fig. 91 (*d*), where a single position of a wave LHL^1 is given, the small arrows showing the general direction of movement in different parts of the wave.

APPENDIX B

Tides.—The gravitational attraction between the Earth and Moon prevents them from following independent paths through

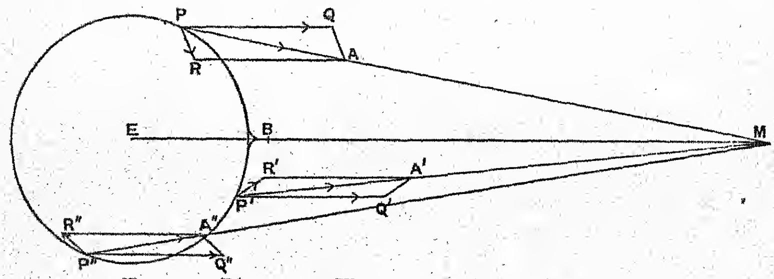


FIG. 92.—Diagram to Illustrate the Cause of the Tides.

space; it is usually said that the Moon revolves about the Earth, but actually they both revolve about their common centre of gravity, the Earth moving round in a small circle and the Moon in a large circle. It is found that any bodies which are compelled by some force (in this case gravitational attraction) to move in a circle, offer resistance to this motion, owing to their inertia or tendency to move forward in a straight line. This resistance is equivalent in its effect to an actual force tending to pull the moving body away from the centre round which it

revolves. It is termed "centrifugal force." At every point on the Earth the centrifugal force is equal and parallel to the centrifugal force at every other point.

The gravitational attraction between two bodies is greater when they are near together, and decreases when they are farther apart. The attraction exerted by the Moon on the surface of the Earth varies, therefore, with the distance of the different points on the surface from the Moon.

In Fig. 92 let E represent the centre of the Earth and M the

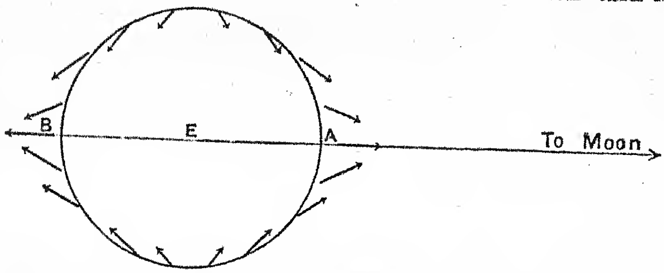


FIG. 93.—Distribution of the Tide-raising Force.

Moon. Let EB represent in direction and magnitude the force exerted by the Moon on a particle at the centre of the Earth. Consider the force exerted by the Moon at a point P, which is nearer to M than E; it will act along the line PA, and since P is nearer to M than E, it will be greater than EB. Let this force be represented in magnitude and direction by PA. Through P draw PQ equal and parallel to EB. Then PQ represents a force equal in magnitude and parallel in direction to EB. Complete the parallelogram PQAR. Then by the parallelogram of forces PQ and PR are equivalent to the single force PA. Similarly, at P′, which is nearer to M than P, the force P′A′ is greater than PA, and can be resolved into the force P′Q′ equal and parallel to EB, and the force P′R′. At P″, which is farther from M than E, the force P″A″ is less than EB, and can be resolved into the forces P″Q″, equal and parallel to EB, and P″R″. Similarly, the force exerted by the Moon at points all round the Earth can be resolved into components equal and parallel to EB (e.g. PQ, P′Q′, and P″Q″) and small complementary components (e.g. PR, P′R′, and P″R″) varying in magnitude and direction

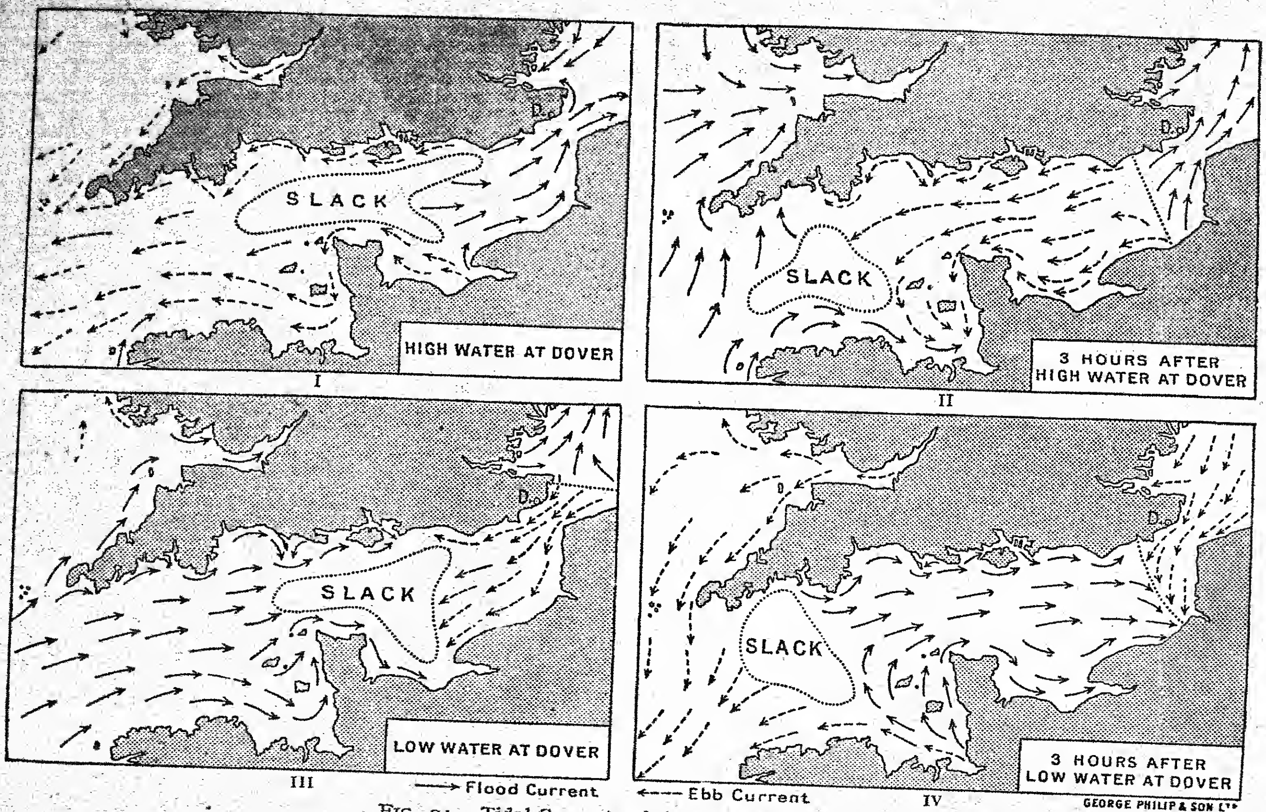


FIG. 94.—Tidal Currents of the English Channel.

according to the position of the point. All the forces equal and parallel to EB are balanced by the " centrifugal force " developed by the Earth's revolution about the common centre of gravity of Earth and Moon The remaining unbalanced forces (PR, P′R′, etc.) constitute the " tide-raising force " over the surface of the Earth at the points P, P′, etc. These alone are shown in Fig. 93, where it will be seen that the force is greatest at A where the Moon is in the zenith, and at B where it is in the nadir.

APPENDIX C

Tidal Currents.—In the case of small waves which rise and fall rapidly the direction of motion of the particles as shown in Fig. 91 (*b*) and (*c*) is reversed every few moments, but in the case of tidal waves, where the distance between crest and trough is very great, the movement in each direction lasts for some hours, and so forms a steady current. The current which moves in the direction of the tidal wave is called the flood, that in the opposite direction the ebb. Fig. 91 (*d*) shows the relation of the flood and the ebb to the rising and falling tides ; high tide occurs at any place when the crest H reaches it, low tide when the trough L reaches it. The important point to notice is that the flood tide continues to run for some time after the tide has begun to fall, i.e. from H to *a*, while the ebb current is running for a part of the time that the tide is rising, i.e. from L′ to *c*. Between the ebb and the flood there is a short interval of slack water, in which no current is running.

An actual example is given in Fig. 94, where the tidal currents of the English Channel are shown. Map I shows high water at Dover and a flood current running through the Strait ; three hours later, although the tide is falling, this current is still running. Map III shows low water at Dover, with an ebb current running down the Channel, while three hours later the ebb current is still running, although the tide is rising.

AUTHORITIES AND BOOKS FOR FURTHER READING.

Works on Physical Geography cited elsewhere, and in addition :—
Marmer : *The Tide* (Appleton).
G. Schott : *Physische Meereskunde* (Leipzig : Sammlung Göschen).
Sir J. Murray : *The Ocean* (Home University Library).
J. T. Jenkins : *Text Book of Oceanography* (Constable).

CHAPTER XI

DISTRIBUTION OF LIFE FORMS

VEGETATION

ing the vegetation of a region, it is of more importance e its general character, whether it is abundant or whether it consists of trees, shrubs or grasses, than of what species of plants it is composed. Plants rent species may possess the same general aspect r, owing to the effect upon them of the same physical

The distribution of vegetations is naturally to the distribution of the factors most important to mely light, heat, moisture and soil. These relation- capable of simple quantitative expression, that is to ndaries of different vegetations cannot be defined parallels of latitude, isotherms or isohyets.

ontrols.—*Light.* Since sunlight is necessary to the f food by plants, growth is arrested during the t is continuous during the daylight. This explains nary rapidity of plant growth in high latitudes mmer days are very long. Where the light is fect seems to be to produce very bright colours That is the case, for example, in Alpine regions, orption of light by the rarefied air is slight, and gions such as the South African veldt.

oisture. Moisture, containing food in solution, is roots of the plant, and is given off or transpired as e under surface of the leaves. In order that the lie, there must be a constant adjustment between of absorption and transpiration. Generally nd shrubs obtain their moisture from the subsoil, bs from the soil itself. Rains well distributed r keep the subsoil moist and promote the growth

of forest and woodland, while light rains, or even heavy rains occurring in a season of great evaporation, only moisten the soil and so are associated with a grassland vegetation. In desert regions where the rare rains occur as heavy downpours, the soil is rapidly parched again, but the subsoil is temporarily moist, hence it supports a few shrubs and plants which have devices for storing water and preventing transpiration.

Where the supply of moisture is great, the leaf surface is large and the trees bear leaves throughout the year; where there is a season of drought sufficiently prolonged to diminish seriously the water in the subsoil, the trees either check transpiration by shedding their leaves, or retard it by various devices. The leaves may, for example, be very small, or even be reduced to thorns or spines, they may be rolled back so that the under surface is not exposed, or they may be covered by a thick skin. In the case of grasses and herbs, those parts which are above ground die down altogether when absorption is not possible. The effects of heat and moisture can hardly be separated. Temperatures may be too high or too low for particular plants, but not for plant life in general; lowly forms of life are found in boiling springs, and at the "cold pole" in Siberia there is forest growth. The temperature of 0° C. is only critical because at or near freezing point water cannot be utilized by the plant. In polar and sub-polar regions the life-cycle is completed in the few short weeks of warm weather, while the remainder of the year is a resting period. In temperate regions subject to prolonged frost there is a resting period of from four to six months, when many of the trees shed their leaves, and the over-ground parts of herbs die down. In those tropical regions where the rain occurs only in the summer months, the latter part of the dry season becomes also a resting season. In regions where there is both a severe winter and a dry summer, the plants appear with a sudden burst in spring, and wither when early summer is past.

In regions where there is a distinct resting season the march of temperature during that season is negligible. Similarly, it is only the amount of rainfall that falls during the vegetative seasons that need usually be considered, and even here the factor of evaporation must be taken into account. In temperate

regions with cold winters the spring is usually dry, but the breaking up of the frost and the melting of the snows supply the moisture necessary for the germination and early growth of the plants. An important source of moisture, other than direct rainfall, is underground water, which may creep up to the surface by capillary attraction and reach the roots of the plants. Hence deep-rooted plants occur in very dry regions.

The permeability or impermeability of the soil is of importance. Thus gravel, chalk or limestone regions will be dry, even when the rainfall is considerable, while a small rainfall suffices to make a clay area wet.

Winds may check or prevent tree growth, either by their destructive violence, or by promoting too rapid transpiration, and so withering up the leaves. Warm winds of the foehn and chinook type serve the useful functions of melting the snows in spring and ripening the fruits in autumn, though their exceptional heat and dryness occasionally ruin crops.

Plant Associations.—The chief vegetation types or associations are the forest, the grassland, and the desert, which correspond roughly to the wet, the scantily-watered, and the almost waterless regions of the world. There are also transitional and mixed types; nowhere is there an abrupt change from one to another.

Equatorial and Monsoon Rain Forests.—These consist of very tall trees, interlaced with creepers, together with shrubs and undergrowth, and are often difficult to penetrate. Some of the trees are deciduous (that is, the leaves fall each year), but plants in leaf, flower or fruit may be found at all seasons; the forest is therefore evergreen. The great variety of plants is a conspicuous feature. The palm is the typical tree of the tropics, the number of species being very great. Hard-woods, dye-woods, bamboos, rubber-yielding trees and creepers, and tree-ferns are also characteristic. These forests are found in the equatorial belt with rain at all seasons, and in summer rainfall regions where the precipitation is over 60 inches, and hence is sufficient to keep the subsoil permanently moist. This type of forest forms what is known as a closed association, that is to say, the plants form a continuous carpet over the soil, whereas in an open association bare patches of rock or soil appear.

Tropical Grasslands or Savannahs.—Grasslands of this kind extend over those regions bordering the equatorial belt which have a long dry season but plentiful rains in summer. The dry season prevents the growth of the dense forest, which needs a constant supply of moisture in the subsoil; the summer rains allow the growth of grasses, which use the soil moisture and complete their life-cycle in a short period. In the dry season the grasses die down, and the general aspect of the region is bare and lifeless. The grasses grow in clumps, sometimes to the height of over six feet. Trees are present, except in savannahs at great altitudes, but they occur singly or in small groups, and are seldom very large. Varieties of palm, acacia, eucalyptus, and baobab are typical, the latter being of exceptional size for a savannah tree. In specially moist places, such as valley bottoms and the windward flanks of mountains, patches of true forest are found. In drier places a dense thorn bush sometimes occurs, and the plants of the savannah often show devices for storing water or checking transpiration.

Deserts.—Deserts are mainly found in the tropical and sub-tropical regions where the rainfall is on an average less than 10 inches, and where none may fall for years. In Central Asia they extend into latitudes usually temperate, the dryness of the air and the continental situation producing high summer temperatures. Plants may be entirely absent over wide areas, especially where there are shifting sand-dunes. More usually they are scattered about singly with long distances between them. Many devices for storing water and checking transpiration are found, and when a rare rain-storm comes the plants blossom and bear fruit with extraordinary rapidity. The numerous species of cactus are typical of the desert; their stems are thick and fleshy and contain stores of water, while their leaves are reduced to spines. In many parts of the desert the dew-fall is heavy, owing to the rapid night-cooling, and this is often sufficient to nourish plant growth when rain is absent. Wherever the conditions become a little more favourable to life, as, for example, where underground water approaches the surface or where a stream from a wetter area penetrates the desert, the vegetation changes; the plants, though retaining their desert characters,

become more abundant, low bushes and dwarf trees may be numerous, while occasional stretches of grassland are found. Such a region is termed semi-desert, scrub or bush, according to its aspect. It generally forms a border round the almost lifeless desert.

Temperate Grasslands.—These grasslands, in particular parts known as pampas, steppes or prairies, are found in regions with hot summers and a moderate rainfall where the subsoil is generally dry. They are usually treeless, but this is not always due to lack of moisture; the looseness of the soil, the occurrence of strong winds, or the periodical destruction of the trees by fire may be contributory causes. In many regions also there is a struggle between the woodland and grassland associations. When once the grass has been allowed to occupy a region, its growth is so vigorous that seedling trees are choked up and destroyed. In spring and early summer the green grass is bright with flowers, but as the heat increases it becomes withered and yellow.

Temperate Broad-leaved Forests.—Forests of this type are found where rainfall is fairly abundant (over 25 in.) and well distributed through the year, but where frost may check absorption in winter. They consist mainly of deciduous trees, such as the oak, beech and maple. Most of the trees are wind-fertilized, and therefore have inconspicuous flowers. These forests contrast with those of the hot regions both because of the absence of bright flowers, and because of their uniformity. There is no great profusion of species, one or two may cover enormous areas. The undergrowth is rarely dense and may be almost entirely absent, as is the case in beech forests.

Where the temperate forest extends equator-wards into a region with higher temperatures and without a decrease in rainfall, as in China and Eastern Australia, it merges into a sub-tropical type intermediate in characteristics between those of temperate and equatorial regions.

Coniferous Forests.—These are found where the winters are severe, the summers short, and the rainfall somewhat scanty. The broad leaves of the trees of the deciduous forests are replaced by the "needles" of such trees as pines, firs, hemlocks and larches, for the needle-like structure checks transpiration and

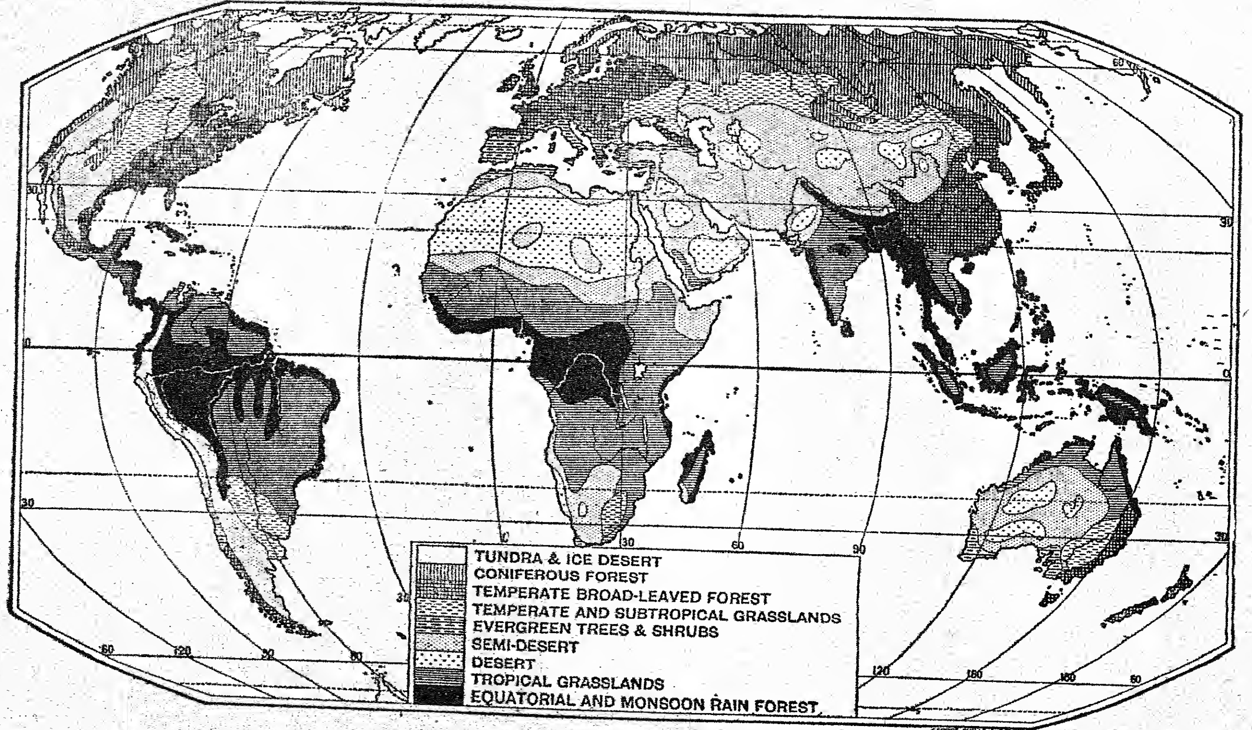


FIG. 95.—Distribution of Natural Vegetation.

is therefore adapted to uniformly dry conditions. Most of these trees retain their leaves during the winter, for the cold season is too long to be taken as a resting period, and warmer intervals at the beginning and end of the season must be utilized, but in this respect the larch and birch are exceptional; the birch is also exceptional in having broad leaves and in not being cone-bearing, but it is nevertheless common in the "coniferous" forest regions.

These forests have also established themselves in some of the mild wet regions favourable to deciduous trees, notably on the west coast of North America, and in such cases the trees may attain to gigantic proportions. In regions where deciduous forests predominate, conifers are found on the colder highlands as on the mountains of Central Europe, and on dry soils as on the sand-barrens of the coastal plain of the United States.

Regions of Evergreen Trees and Shrubs.—These are regions of the "Mediterranean" type, with summer droughts. Here, since the rainfall occurs in the cooler seasons when the evaporation is not great, the subsoil is moist, but the moisture must be husbanded in summer, hence the plants show various adaptations to dry conditions; the trees, which are evergreen, are small, and have small tough-skinned leaves and deep roots, while heaths with rolled back leaves and bulbous plants are numerous. Grasses are not abundant, their place being taken by flowering herbs and small bushes. A forest growth is found where the rainfall is most plentiful, as, for example, the forests of cork-oak in Portugal and Morocco. The prevailing tone of the vegetation is a sombre grey-green. The holm-oak, olive and myrtle show the typical characters of the plants of this association.

Tundras and Ice Deserts.—These are found in the polar regions where the warmest month has a temperature of less than 10° C., and the precipitation is small and occurs chiefly as snow. On the tundras the subsoil is permanently frozen to a depth of several feet, and only the surface thaws during the brief summer. On the margin of this region small tough bushes are numerous, and within it these give place to a great variety of mosses and lichens. In sheltered hollows a few flowering annuals appear in summer. The ice deserts are practically devoid of life; the land is covered with a perpetual sheet of ice and snow. This is the condition

of the interior of Greenland, many of the Arctic islands, and the land around the South Pole.

Mountain Associations of different types follow one another in succession as the altitude increases. The change is at first due to the decrease of temperature, for the rainfall on the lower slopes of mountains is usually abundant. At very high levels the precipitation falls off, owing to the greatly decreased capacity of the air for water vapour; here, too, the snow-fields which cover the ground for part or the whole of the year affect the vegetation.

Most mountains are forested, and in equatorial regions a complete series of vegetations may be found. The dense equatorial forest gives way gradually to the temperate broad-leaved forest and this to the coniferous type; then the trees become gradually dwarfed as their upper limit is approached, while shrubs and bushes are more abundant. Meadows covered with a rich growth of grasses and flowering herbs occur in the bottoms of high valleys, and in regions covered by snow in winter but abundantly watered by the melting snows in spring. Above the level of shrubs and meadows a semi-desert region of tundra-like aspect may be found, just below the limit of perpetual snow.

On lofty, cold, dry plateaus such as those of Tibet and the Andes, a semi-desert vegetation consisting mainly of scattered bushes and coarse grass is found.

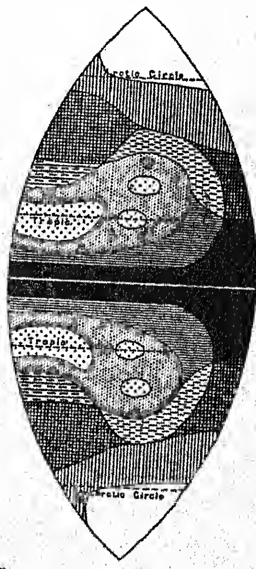


FIG. 96.—Schematic Diagram showing Distribution of Natural Vegetation. [For Reference to marking see Fig. 95.]

World Distribution.—The broad distribution of these vegetations is shown in the map (Fig. 95) and is expressed diagrammatically in Fig. 96. In general a western marginal, an eastern marginal, and a continental sequence of associations may be traced.

Western Marginal Vegetations. Considering the types from the equator pole-

wards, it is seen that the equatorial forest is succeeded by the savannah as the rainfall diminishes, and this merges gradually into semi-desert and desert. The latter usually lies about the tropic. On the pole-ward side of the desert, a semi-desert is followed by a "Mediterranean" type of vegetation. As the rainfall becomes more abundant in summer, this gives place to temperate broad-leaved forest, followed in still higher latitudes by coniferous forest.

Eastern Marginal Vegetations.—The eastern margin differs climatically from the western chiefly as regards the higher rainfall of the tropical and sub-tropical belts, and the lower temperatures of high latitudes. The equatorial forest merges into a sub-tropical forest (with perhaps an intermediate savannah region), and this in turn into a temperate broad-leaved forest, a coniferous forest, and finally tundra.

Continental Vegetations.—Low rainfall is the predominant note of continental climate outside the equatorial belt. In addition, there are the high temperatures of the tropical regions, and the great extremes of temperature of the temperate regions. Hence the deserts and grasslands have here their greatest development. The succession is as follows :—equatorial forest, savannah, semi-desert, desert, semi-desert, temperate grassland, coniferous forest, tundra.

In tracing these series of vegetations on the map in Fig. 95, the natural conditions which cause unusual limitations or extensions of the belts should be noted. Thus in Europe the penetrating inland seas give an exceptional extension to the western marginal conditions, while in the Americas the cordillera confine them to the coastal regions. In temperate South America, the narrowness of the continent has eliminated the eastern marginal area altogether.

Ocean Vegetation.—In tidal waters there is a great abundance of seaweeds attached to the rocks and to the sea-floor. A limit is set to their growth by the depth to which sufficient light can penetrate ; at a greater depth than 200 fathoms the vegetation is scanty. In the open sea, it consists of innumerable floating plants of microscopic size, which occupy the sufficiently illuminated waters. These plants, which form the food material for

the marine animals, are borne along by the ocean currents, and give to these an additional importance. The name plankton is applied to all living, floating organisms, whether animal or vegetable.

ANIMALS

The distribution of animals is bound up with the distribution of supplies of water and food. Most animals can adapt themselves to very varying temperature conditions, and hence their range is chiefly limited by such barriers as the ocean, the desert, or a great mountain chain. But the areas over which the various species are now found are much more limited than those which once formed their home. The destruction of natural vegetation, the introduction of domestic animals, and the practice of hunting wild animals all tend to restrict their range and their numbers.

The vegetable world forms the basis of all animal life. The abundance or scarcity of plants determines the abundance or scarcity of plant-feeders, and the number of these in turn determines the number of flesh-feeders. Invertebrates, such as insects, molluscs and worms, which feed on fresh and decayed vegetation, form a very large proportion of the animals of every region. They are the chief food of many birds, reptiles and small mammals. The larger mammals, such as the grazing animals and the carnivorous animals which hunt them, and the great birds of prey which live upon both the invertebrates and the smaller mammals, are relatively insignificant as far as numbers are concerned.

Animal life in certain regions shows periodic change similar to, but less marked than that of the plants. The occurrence of a resting season in the vegetable kingdom, by cutting off the food supply, causes a cessation in the active life of many invertebrates. Some pass the season in the form of eggs or pupae, others in a state of suspended animation, and the animals which feed upon them are then compelled either to hibernate or to migrate to another region. There is not, however, an entire absence of food: seeds, berries, fruits, nuts, roots and underground stems supply many birds and mammals, which in their turn are food for larger animals.

Since animals can adapt themselves to very varying conditions, and since few observations have been made except of the higher forms, it is impossible to divide the world up into areas occupied by definite associations of animals, but certain regions have their marked peculiarities.

Animal Life in the Forests.—In the hot, wet forests, with their wealth of vegetation, there is an enormous development of bird and insect life, and great numbers of animals are adapted to a life in trees. Such forests are alive with birds and monkeys, and there are many tree-frogs, tree-snakes and tree-lizards. Owing to the density of the undergrowth there are few animals of any size which cannot climb or fly. Only the elephant, with its vast bulk, can force a path through the virgin forest.

Wherever the forest becomes more open, the number of ground-dwelling animals increases. In the deciduous and coniferous forests there are many animals of the type of the wild boars and wolves of Europe. Various species of wild cats, squirrels, opossums and flying foxes show adaptation to life among trees. In the coniferous forests the most important fur-bearing animals of the world are found.

Animal Life in the Grass and Scrub Lands.—Here there are flocks and herds of grazing animals, including antelopes, deer, and wild varieties of the ass, horse, camel, and ox. Dependent upon them are the larger beasts of prey—lions, tigers, jackals, hyenas. Partly because the grazing animals are defenceless against their enemies, and partly because they must often travel long distances in search of water or fresh pasture, they are endowed with the power of very rapid movement. It is in these regions that the swift-running, flightless birds, such as the ostrich, emu, rhea and cassowary are found. Burrowing animals, and especially rodents, are very numerous in the grass and scrub lands; they obtain their food from the thick roots and underground stems developed by plants in consequence of the scanty rainfall. They are generally found living in large colonies in burrows which form a refuge from the carnivorous animals which prey upon them, and a protection against extremes of temperature. The jack-rabbit, jerboa and coney are examples.

Life in these regions shows marked periodic changes. In

the temperate zone, the larger animals move northwards or up the mountains in summer, southwards or down to the sheltered valleys in winter; in the tropics the movement is away from or towards the equator with the swing of the rainfall belt, or it may be towards the river valleys and permanent water-holes, as the season changes from wet to dry. In the cold or dry season the smaller animals considerably decrease in numbers or pass the time in sleep.

Protective colouring is well shown in the grasslands. In the vegetative season the tall grasses and bushes afford abundant cover for the game, but when the summer heat has withered all the plants, the brown, tawny or striped coats of the larger animals harmonize with the prevailing tones of the bare rocks and the scanty vegetation, and so render them less easily discovered.

Animal Life in the Deserts.—The deserts have a very restricted animal life; the scanty vegetation supports insects and rodents, and there are also reptiles and a few birds. The yellowish-brown colour of these animals renders them practically indistinguishable from the sand and rocks. The larger animals of the grass and scrub lands may be met with in the desert, moving from oasis to oasis. The broad, padded hoof of the camel is well adapted to travel across the yielding sand.

Animal Life in the Tundras.—Here the pools and boggy places, formed when the surface thaws, are the breeding ground of innumerable insects, and flocks of birds fly pole-wards in the summer to feed on these. Certain grazing animals, such as the reindeer and elk, feed on the mosses and lichens. The low berry-bearing bushes which grow in the more favoured situations support a few birds and rodents, and these in turn some beasts of prey. The hard conditions of life lead to the development of very special protective colour devices. The arctic fox, hare, and ptarmigan have in summer a brownish colouring which harmonizes exactly with that of the lichen-covered rocks, but in winter their coats are pure white, so that they are invisible against the snow.

The ocean margins in all parts of the world are the home of great flocks of sea-birds, which catch fish or live on the sea

animals exposed by the tide or cast up by the waves. These birds and the polar bear form almost the sole life of the polar regions, where the absence of vegetation makes the sea the only source of food.

Life in the Oceans.—The oceans may be divided into three regions, the littoral, the pelagic, and the abyssal. The *littoral region* where the waters are shallow, has the richest vegetation, and hence supports the most abundant animal life. It forms the breeding and feeding ground of countless fish, and the most important fishing grounds are on the continental shelf, or littoral region of the temperate lands, where edible species are most numerous. The *pelagic region* has a vegetation of plankton, which is the basis of life. With vegetable plankton animal plankton is associated, and the two form the food of the whale, one of the most important animals in this region. The *abyssal region* comprises the areas beyond the range of the penetration of light where there is no vegetable life, and hence all the animals either live on decayed organic matter or are carnivorous.

Authorities and Books for Further Reading.

A. F. W. Schimper: *Plant Geography* (Oxford Press).
E. de Martonne: *Traité de Géographie Physique* (Paris: Armand Colin).
Obst-Supan: *Grundzüge der Physischen Erdkunde* (Leipzig: Veit).
M. Hardy: *Plant Geography* (Oxford Press).
M. Newbigin: *Animal Geography* (Oxford Press).
M. Newbigin: *Plant and Animal Geography* (Methuen). [More advanced than the preceding two books.]
M. D. Haviland: *Forest, Steppe and Tundra—Studies in Animal Environment* (Cambridge Press).
V. C. Finch and G. T. Trewartha: *Elements of Geography* (New York: McGraw-Hill).

CHAPTER XII

THE PEOPLES OF THE WORLD

It is a matter of common knowledge that the people who inhabit different parts of the world differ from one another in many respects. For example, the typical Englishman of East Anglia may be contrasted with the typical Negro of the Sudan, and both the Englishman and the Negro with the typical Chinese of the Yangtse Basin. It will then appear that these three differ from one another in their physical characteristics, in their mental characteristics (which are much more difficult to ascertain and to classify), in their languages, and in their religions. [1]

Thus there are the following obvious differences: the typical Englishman is taller than most inhabitants of the globe, being about 5 feet 8 inches in height, has more or less wavy hair of medium length, and a fair coloured skin, whitish with a reddish tinge; the typical Negro is as tall, but has short and woolly hair arranged in very close and interlocking spirals, and a very dark, perhaps black skin, while his lips are thick, his nose flat and broad, and the lower part of his face projects markedly beyond the upper part; the typical Chinese is considerably shorter, being about 5 feet 4 inches in height, has long and straight hair, and a yellowish skin, while his eyes are narrow and oblique, and his cheekbones high and prominent.

Beyond these obvious physical differences there are others less apparent. A measurement of the head of the Englishman reveals the fact that the length of his skull from front to back is much greater than the breadth, the ratio of length to breadth being about 100 : 78; the skull of the Negro is still longer in proportion to its breadth, the ratio being about 100 : 75; while

[1] It is important not to confuse physical and mental characteristics. In intelligence and capacity dark-skinned peoples are equal to those with white skins. Isolation, poverty and lack of educational opportunity are principal causes of so-called backwardness, and very great changes are now in progress in these respects.

the length of the skull of the Chinese is less marked, the ratio being about 100 : 81.

These and other physical differences are so considerable that we say the English, Negroes and Chinese belong to different races, and one object of this chapter is to discuss the characteristics of the peoples of the world, to divide them into various races, and in some degree to explain their distribution. In this connexion, as in the maps in Figs. 97 to 100, the complications following from the recent immigrations of Europeans into the Americas, Africa, and Australasia are omitted; only the natives of these continents are first studied, and the modifications due to European immigration are discussed later.

It is again a matter of common knowledge that in the three cases just considered the languages of the people are also quite different, but it must be realized that a difference of language does not always accompany a difference of physical characteristics, e.g. a Negro child born and educated in England would speak perfect English; also a similarity of language does not always accompany a similarity of physical characteristics, for history gives us many examples of an invading people permanently imposing their own language on a conquered nation. It is therefore important to bear in mind that language is not a sure indication of race.

In the same way, differences of religion must not be confused with differences of racial qualities, though in the examples quoted the typical Englishman is Christian, the Negro is Mahometan, and many Chinese are Buddhists. For this reason it is well, as far as possible, to apply to the various races no names which are applied either to any language or group of languages, or to any religion; the three ideas of race, language and religion should be kept distinct, or confusion and error will result.

Classification of Races.—These considerations suggest that to classify people into their races, one must examine not only their characteristics but how these were obtained. The characteristics which people have because of their descent may be taken as a guide, but those which are acquired (whether they are physical or concerned with language or religion) do not indicate the stock from which the people come, and are therefore no criteria of their

race. The question therefore remains as to which physical characteristics are an indication of race, and the answer to that depends upon the further question whether the particular characteristics are transmitted unchanged through successive generations, or whether they can be produced or altered by external circumstances.

If skin colour is considered from this point of view, it must be borne in mind that all the varying tints are due to the amount of brown colouring pigment in the cells under the outer skin; similarly all differences of colour in hair and in eyes are due to the amount and distribution of the same brown pigment. The "tanning" of the skin after unusual exposure to the Sun's rays is brought about by an increase in the amount of the pigment, but no change in hair or eyes is observed, and the "tanning" of the skin is not transmitted to children. The fact of "tanning" does, however, suggest a certain connexion between climate and colouration, and this connexion is suggested also by the map showing the distribution of the colour of the skin (Fig. 97). This map shows that the darkest colouration is in peoples living within the tropics, with the exception of the now extinct Tasmanians, and in all probability these migrated from the island region north of Australia, while at the other extreme the fairest peoples are those of Northern Europe. It has also to be remembered that the people of the equatorial forests are sheltered from the Sun's rays, and so the darkest skin colouration is not likely to be found in those forests; also the case of those Polynesians who are comparatively fair-skinned can be explained by the fact that they represent comparatively recent immigrants. Marked pigmentation is a protection against excessive insolation, and this pigmentation affects not only the colour of the skin but also that of the hair and eyes, blue eyes corresponding in this respect to a fair skin. Hence in very sunny regions, dark pigmentation has a "survival-value" for the individuals who possess it; in the long run natural selection weeds out those who do not, while the darker individuals survive and transmit their characters to their children. Yet it takes a very long time for natural selection to act in this way, and when people immigrate into a new region their descendants

show their different origin by their abnormal colouration over many generations.

Stature may be considered from the same point of view. Although in any one people the heights of the individuals vary, yet the average height of one people may be markedly different from that of another people, as can be seen from the map in Fig. 98. Peoples differ in height sufficiently for us to associate a certain average stature with a certain people, and in some cases of a recent intrusion of a people into a region we can recognize their effect in raising or lowering the average stature of the people among whom they settle. Yet an unfavourable environment or diet may prevent individuals or whole populations from reaching the stature which their hereditary tendencies would allow, and hence stature must be used with care as a test of race.

The texture of the hair is of three main types (straight, wavy and woolly) as described above, and the distribution of these is shown in Fig. 99. This characteristic is transmitted without modification due to environment, and is therefore a trustworthy indication of race.

Similarly the shape of the skull is apparently transmitted unaffected by environment, and the division of peoples into long-skulled and broad-skulled folk is one which serves both in classification and in determining race, although it may not be very obvious to the unskilled observer.

Facial peculiarities, e.g. in regard to the eyes, nose and jaw, are useful indications of race, but these peculiarities are more limited in their distribution over the Earth, so that while they may be employed in determining the descent of certain peoples among whom they appear, they cannot be applied so well to the question of dividing the peoples of the world into their great racial divisions.

The Races of Europe.—The most useful classification of races is that obtained by dividing them into three groups, the woolly-haired, wavy-haired and straight-haired groups. By reference to Fig. 99 it is seen that the woolly-haired races are found in Africa south of the Sahara, and in Melanesia ; the wavy-haired

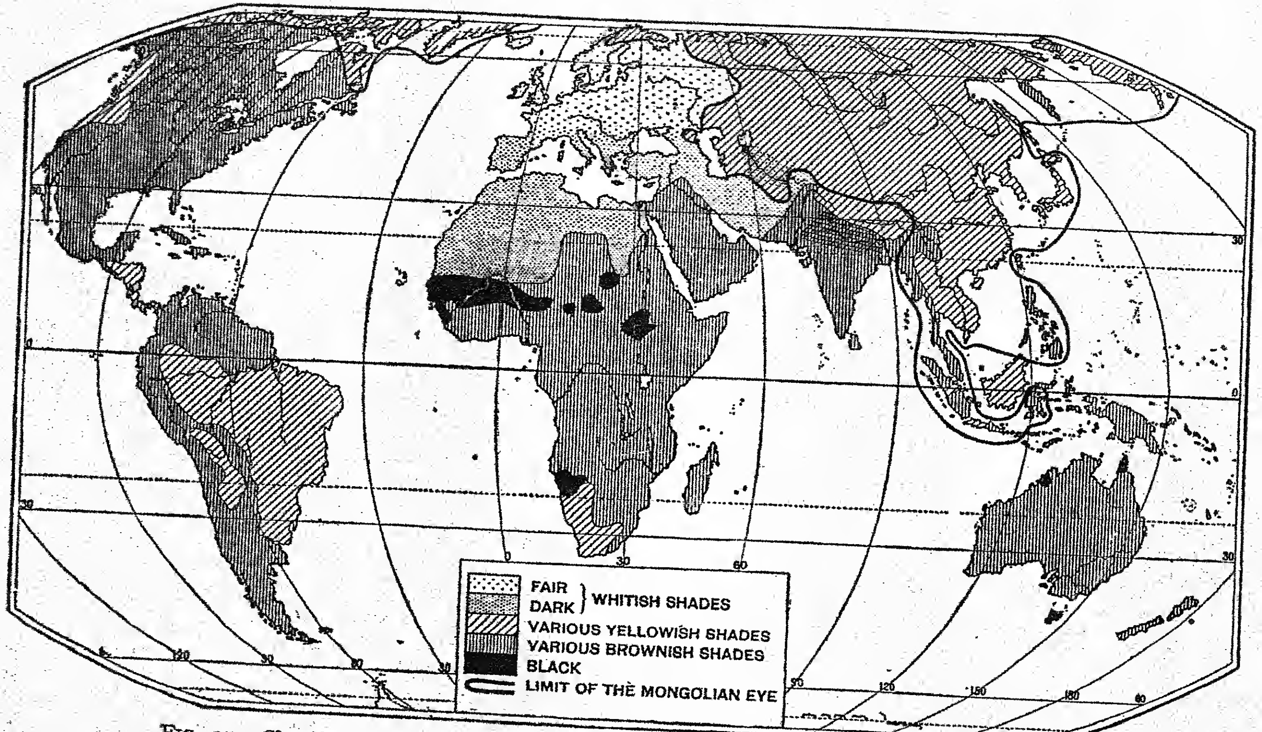


FIG. 97.—Classification of Native Peoples according to Skin Colour. (Based upon Gerland.)

peoples in Europe, North Africa, South-west Asia and Australasia; while the straight-haired people occupy the greater part of Asia and all the Americas.

A consideration of skull-form, the other good test of race, shows that these groups must be sub-divided. To take the case of the peoples of Europe, it is at once apparent on examining the map showing the texture of the hair that, with the exception of the east of Russia, Europe is inhabited only by the wavy-haired peoples, yet a consideration of skull-form (see Fig. 100), the other accepted criterion, shows that the broad-skulled peoples of Central Europe must be of different origin, that is to say of different race, from the long-skulled peoples of Spain in the south and also from the equally long-skulled peoples of Scandinavia in the north.

The further question then arises whether the northern and southern Europeans are of the same race, and in this inquiry both colouration and stature point to the conclusion that there are at least three more or less definite racial groups, which overlap considerably.[1] From Fig. 97 it is evident that the peoples of southern Europe have a darker skin than those of Northern Europe, and, moreover, light eyes and fair hair are distinctive of the latter. Fig. 98 shows that while the Scandinavians are above the average height the inhabitants of Spain are below the average, and those of Portugal still shorter. Hence we conclude that the "Nordic" race, represented in its least mixed form in Scandinavia, Denmark, North Germany, and the East of Great Britain, is long-skulled, tall and fair; the "Mediterranean" race, well seen in Spain and southern Italy, is long-skulled, short and dark; the "Alpine" race,[2] centred in the

[1] Before it was realized that there were three distinct European races, the wavy-haired peoples of Europe and South-west Asia were classed together as the "Aryan" or "Caucasic" race. In addition to their incomplete classification, these terms were misleading, for "Aryan" refers to the European group of *languages* and, therefore, should not be used to denote races, who may or may not speak those languages, and the idea that Caucasia was the place where the "Caucasic race" originated is now completely discredited.

[2] The term "Keltic" has been employed for this race, but this name is used for the languages which the ancestors of these peoples brought with them, and in consequence much confusion of thought has arisen from its application to *peoples*.

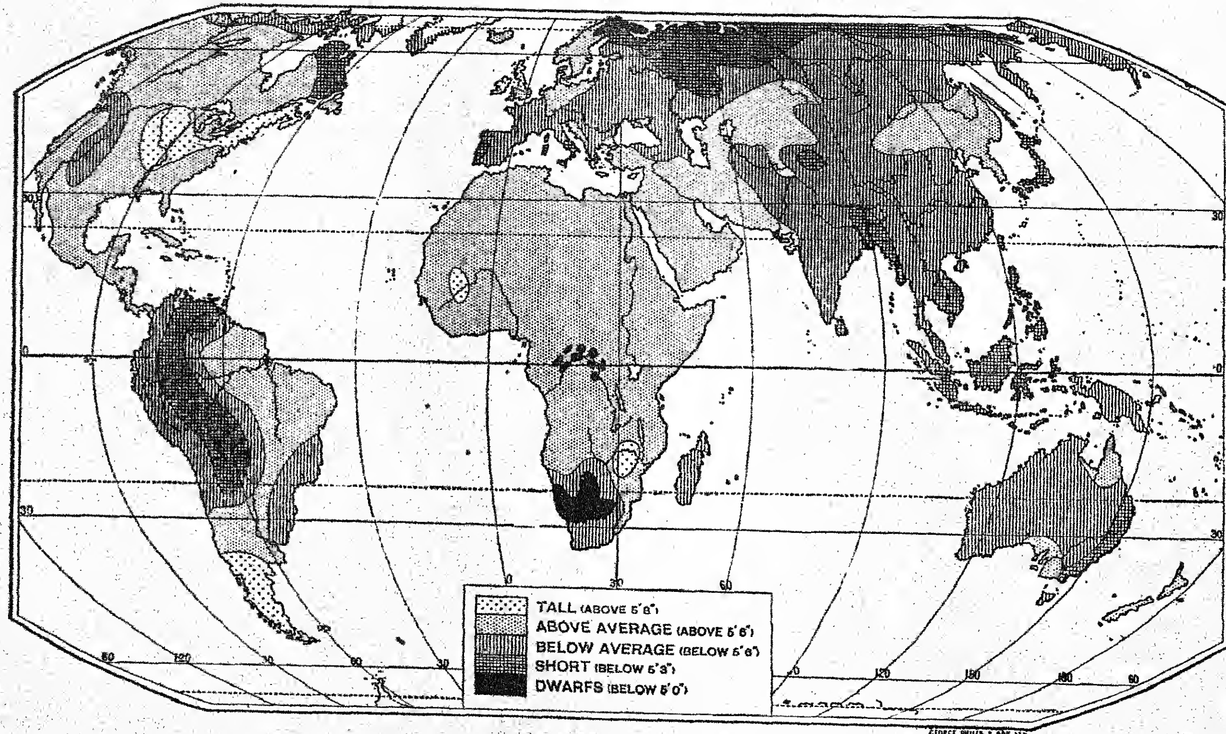


FIG. 98.—Classification of Native Peoples according to Stature. (After Ripley.)

Alps and stretching across Europe from west to east, mainly in the highlands but also occupying the greater part of the plain of Russia, is broad-skulled, and intermediate in regard to colouration and stature.

In Russia there has been an intrusion of Asiatic races, as may be seen by the westward extension of the marking denoting straight-haired peoples on Fig. 99, and other peoples resulting from Asiatic intrusions are found in south-eastern Europe. These peoples are described in later paragraphs in this chapter. Moreover, the three European races have intermingled, both by peaceful extension and warlike migration, and so certain regions, as in parts of the British Isles, have peoples whose characteristics show a blending of various types.

The Races of Asia.—Just as the wavy-haired races predominate in Europe, so the straight-haired races predominate in Asia. By comparing the maps, it is seen that the peoples of the north-east have long, straight hair, are broad-skulled, are of less than the average height and have yellowish skins. They have also the "Mongolian" eye, which is commonly observed among the Chinese and Japanese. The word "Mongolian" originally referred to a particular people who live on the Mongolian Plateau, but the use of the term "Mongolian" has been extended to all the peoples of Asia who exhibit the characteristics just enumerated. It is desirable to divide these peoples into two groups, the Northern Mongolians of Central and Northern Asia, and the Southern Mongolians of South-eastern Asia.

Northern Asia.—The aboriginal people of the northern part of Asia seem to be represented by the present inhabitants of north-eastern Siberia, who are therefore called Palaeasiatics (see Fig. 101). They have been driven into this region by the Mongols—the true Mongols of the Plateau.

Between the tribes classified as Palaeasiatics and the Mongols of the habitable lands on the margin of the Gobi Desert, live the Tungus, tribes extending from the Lower and Upper Tunguska rivers to the Sea of Okhotsk and the Sea of Japan. These tribes differ somewhat from the Mongols because of a certain mixing of their Mongolian characteristics with those of the primitive Palaeasiatics, e.g. the Tungus have a rather longer and less

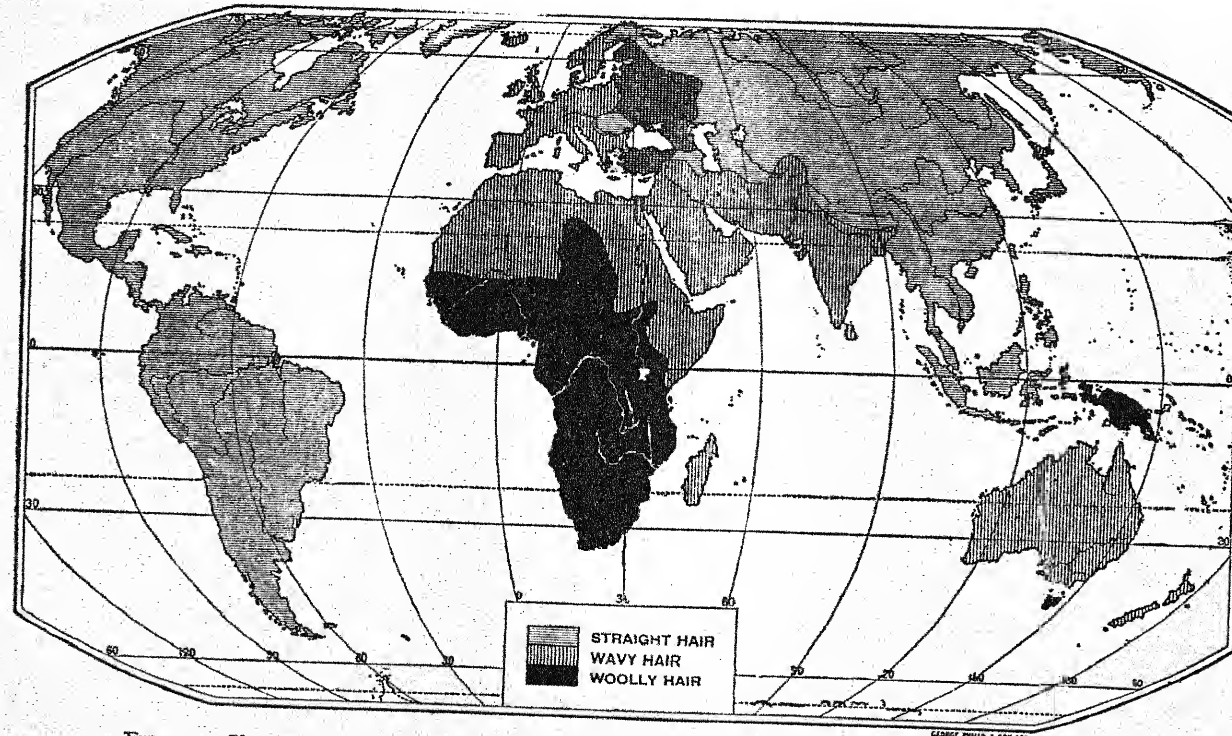


FIG. 99.—Classification of Native Peoples according to Hair Texture. (After Gerland and Ripley.)

[The cross-ruling indicates areas where straight hair and wavy hair are both common.]

broad face than the Mongols. The Manchus, who now form only a small proportion of the inhabitants of Manchuria, belong to the Tungus group, but are taller; this difference is also seen in the Koreans. Indeed it is probable that long before the times of which there is any written record, there was a mixture of the Mongolians with another race of quite different characteristics, for still further east, in the south of Sakhalin and the north of Yezo, are the Ainus, who are long-skulled, have wavy hair and heavy beards, and have not the Mongolian eye. The Ainus may be regarded as the modern representatives of a race which by some mingling with the Mongolians gave rise to the present peculiarities of the Manchus and Koreans.

In the north-west of Asia another blending of the Northern Mongolian stock seems to have occurred. A long-skulled people, possibly akin to the Northern European race, seems to have migrated into Asia, and by mixing with the Asiatics to have produced the two great Western groups of the Mongolians, the Ugro-Finns and the Turki peoples. In both of these groups the skin is rather a yellowish-white than a yellow colour, and the Mongolian eye is frequently absent among the Western Ugro-Finns and seldom found at all among the Turki peoples.

The Ugro-Finns have spread outwards from the region of the Ural Mountains, and include the Ostyaks of the basin of the lower portion of the Ob river, the Samoyads of the western portion of the Asiatic Tundra, and the Lapps of north-eastern Scandinavia. Partly derived from the same race, but greatly modified by admixture with Europeans, are the Finns of Finland, several small groups in Russia in Europe, and the still more Europeanized Magyars of Hungary and Bulgars of Bulgaria.

The Turki peoples are widely scattered. Separated from the others, far to the east are the Yakuts, stretching widely on either side of the Lena River. The heart of the Turki country may be regarded as Russian Turkestan, and there the people form the Kirghiz tribes. These may be divided into the Kazak (i.e. Rider) Kirghiz of the steppes, and the Kara (i.e. Black) Kirghiz of the highlands to the south-east. The Kazaks (whose name has been altered into the familiar "Kossacks") have extended into the steppes of European Russia, together with their kinsmen the

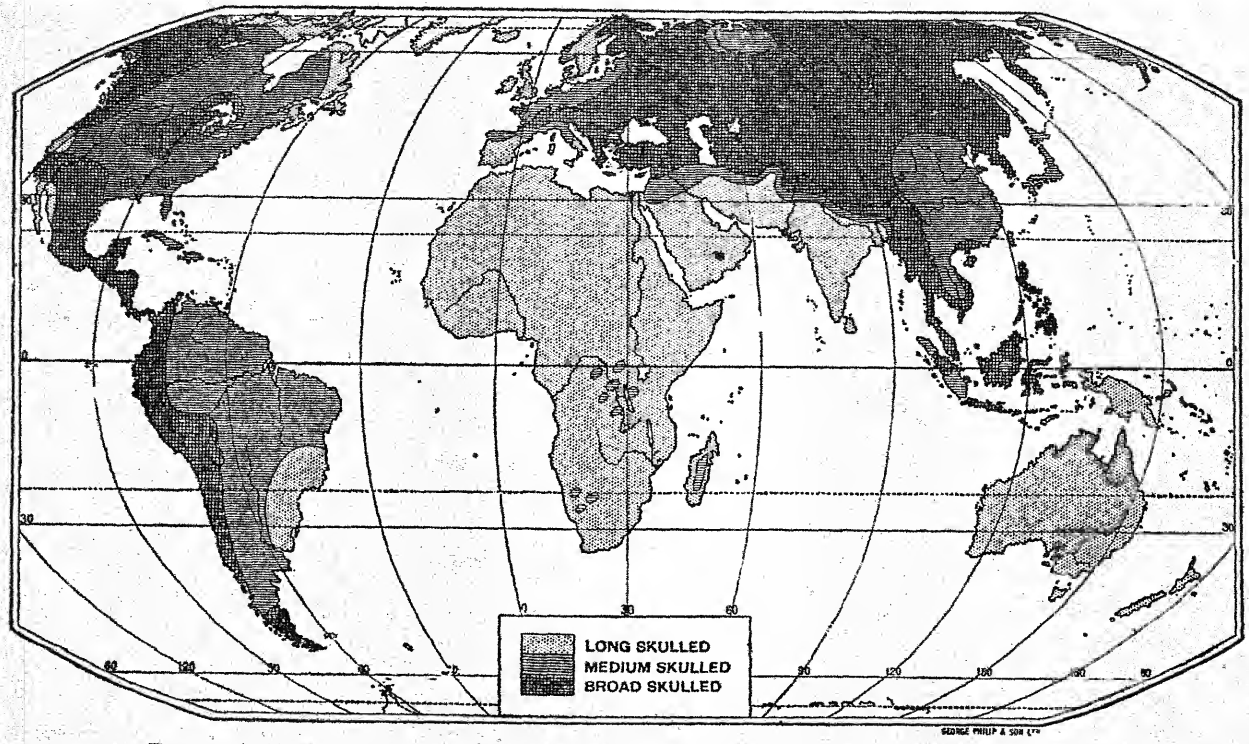


FIG. 100.—Classification of Native Peoples according to Skull Form. (Based upon Ripley.)

Tatars. West and south of the Sea of Aral are the Turkomans, while the Osmanli Turks have largely occupied Asia Minor and intruded into Turkey in Europe and the districts west of the Black Sea.

The small stature of the people of the extreme north of Asia is worthy of notice (see Fig. 98), for as has been now shown, these peoples are of different races and yet are all short, while

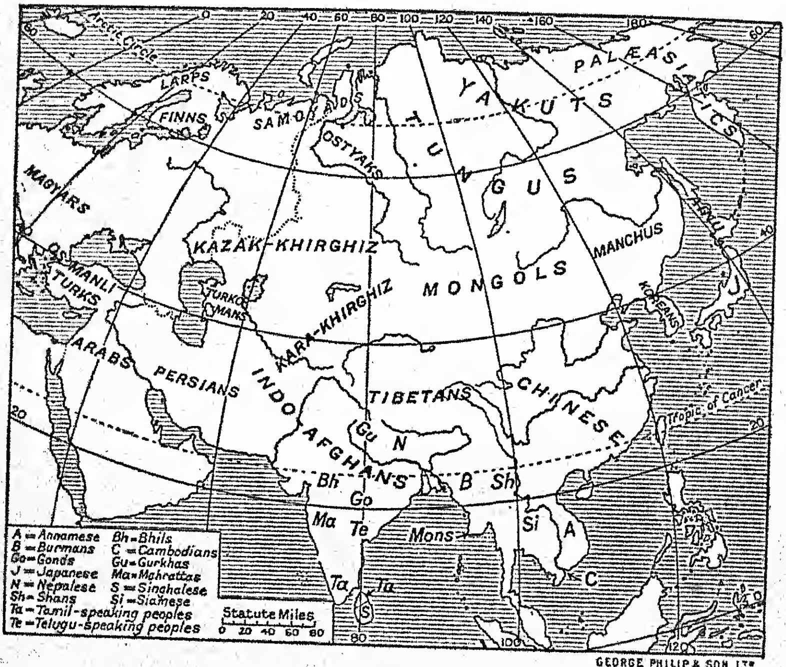


FIG. 101.—Peoples of Asia.

other peoples of the south who are akin to them are considerably taller. There is every indication that their inhospitable environment is the cause of their low stature.

South-Western Asia.—It is evident, therefore, that the boundary between Europe and Asia does not divide peoples according to race, and this is still more apparent when the south-western portions are considered, for the wavy-haired group of peoples stretches without a break from southern Europe to Assam.

To the "Mediterranean" race belonged the first-comers among the peoples inhabiting Asia Minor; these are now found on the coast and in the larger towns, and also include the Kurds. The "Alpine" race were later immigrants, and these were the ancestors of the present Armenians. Comparatively recently the straight-haired Osmanli Turks intruded; these were the ancestors of the present day Turks, who are still frequently nomadic but by intermixing with other inhabitants have become similar to them in many physical characteristics. This mixture of races is still more marked in the Caucasus region. The map in Fig. 100 shows that the average skull-form is broad in Asia Minor, owing to the intrusion of two broad-skulled races upon an originally long-skulled population, although the Mongolian strain has not been sufficient to cause the greater number of the people to have straight hair. The lands around the Arabian desert are occupied by the Semitic branch of the Mediterranean race, which includes the Jews and the Arabs.

The Persians also exhibit the typically Mediterranean characteristics, and in parts show the effect of both Turki and Arab immigrations. Afghanistan and Baluchistan are also inhabited mainly by people akin to those of the Mediterranean region, but the Pamir highlands seem to be peopled by the Alpine stock, which here, as in so many other cases, appears to be specially adapted to highland conditions.

India.—The population of India is extraordinarily complex (notice the map in Fig. 97), and at least six different stocks must be distinguished.

(1) The Dekkan is largely inhabited by Dravidians, a wavy-haired, long-skulled, brown-skinned and short race. This includes the Bhils in the west of the northern part of the Dekkan; the Gonds in the centre of the northern part; the Mahrattas in the western part; and in the south, the Telegu and Tamil speaking peoples, the latter of whom have spread into the northern part of Ceylon.

(2) Among the Dravidians are found some isolated tribes of a lower type belonging to a still darker and shorter race. This race was in all probability the earliest to inhabit India, and was displaced by the Dravidians; hence the term "Pre-Dravidian"

has been applied to it. Besides the few tribes in the south of India it includes the Veddas of Ceylon, and its influence can be traced as far east as Australia.

(3) The north of India was long ago, about 2,000 years B.C., entered by a taller and fairer people known as "Aryas," now placed in the group termed "Indo-Afghans," and akin to the Mediterranean peoples of Europe. These new-comers mingled with the aborigines, and their descendants were modified by later comers, but their characteristics are still to be seen in the present population, and probably most purely in the Sikhs of the Punjab. The Rajputs claim descent from the same race, but later and historic intrusions have in many cases made this claim little more than traditional. Farther to the east, in the Jumna-Ganges region, the effect of this Indo-Afghan influence is less apparent, and in Bengal it has been still less, so that here the earlier Dravidian type is but little modified. This is exemplified by the decrease in stature from Afghanistan to Bengal indicated in Fig. 98.

(4) From about 150 B.C. onwards, wave after wave of invaders belonging to the Mongolian races poured into India, conquering and plundering and to some extent modifying the population. Thus the Scythians first overran the basin of the Indus, and in the fifth century A.D. one branch of the Huns conquered all the north of India at the very time that their kinsmen penetrated into the west of Europe. From 1000 A.D. other conquests led to the extension of the Mahometan religion and the establishment of empires, notably the Great Moghul empire, but they had little influence in the matter of race.

(5) In the extreme east of Bengal and in Assam it seems that there existed a wavy-haired stock, which was neither Dravidian nor Pre-Dravidian, being taller and with a lighter skin than either. In these respects the people of this stock are more like the Indo-Afghans, but the features are less European in type, the nose, for instance, being broader and less prominent. As this race is found represented throughout the island groups as far as Polynesia, it has been called "Indonesian," and it is possible that in its origin it was connected with the European races; certainly both the Indonesians and the Polynesians (described below)

must be classed with the wavy-haired Europeans rather than with the straight-haired Mongolians or the woolly-haired Negroes. The present people of eastern India are descended from the Indonesian stock with modifications due to mixing with Dravidian elements and to intrusions of tribes of the Southern Mongolian group who came from the east. Therefore on the eastern border of India, the Mongolian traits become more noticeable, as is indicated by the maps showing the broadening of the skull-form and the occurrence of the Mongolian eye.

(6) Not only in the mountainous country of the eastern borders, but also in the mountainous country of the Himalayan districts, does the population belong to the Southern Mongolian group. Here are, for example, the Gurkhas and Nepalese, short hardy people, fierce fighters, who in many ways remind one of the Japanese. These Indian peoples are akin to the Tibetans on the north of the great range.

South-Eastern Asia.—The Chinese best represent the Southern Mongolians, though even in this case there has been some blending with an earlier stock whose descendants are to be seen in the secluded south-western portions of the country, where many of the people have stature, features, and sometimes even hair, more like Europeans than Chinese.

The people of Japan are also of the same Mongolian race, but in these islands, accessible to several surrounding peoples, there has certainly been an infusion of Korean blood, and in all probability Ainu and Polynesian elements are also represented in the Japanese.

The position of China, almost entirely shut in beween deserts, mountains and the sea, has enabled its people to keep themselves from foreign intrusions, but Japan has acted as a trap allowing immigrations from the north, west and south, and retaining and blending the elements thus introduced. It should be noted that if several races are blended together there is a tendency for the most useful physical and mental characteristics of each race to persist, and the resulting population may therefore be an advance upon any of the original stocks. It cannot be doubted that this composite character of the Japanese population is one factor in making them able to adapt themselves to

modern European ways much more readily than the Chinese, who are more of one type, very conservative in character, and at present far behind the Japanese in their development.

The various peoples of Burma occupy just those portions of the country which their history would lead one to expect. Probably the earliest inhabitants were of the Indonesian race and are represented by the people of the Mergui Archipelago, where they have been safe from intruders, for from the north and the east, long before the Christian era, there were invasions of the Southern Mongolians. First came the Mons, afterwards forced into the region of the delta of the Irawadi; later the Burmans, who now occupy the greater part of the country; and later still the Shans and Karens of the east.

In a similar way the position of the peoples of Siam and French Indo-China illustrates their racial history. The Cambodians are taller than the people to the north of them, and many of them have wavy hair; they have been driven to the delta of the Mekong by the pressure of the Mongolians behind them. These are the Annamese and the Siamese, the latter of whom are mainly from the same stock as the Shans.

The Malay Region.—The Malay Region is inhabited by representatives of each of the three great racial divisions [1]; it is a bridge on which several races have left abiding traces of their occupation and passage. As in the case of Indo-China, the chief strain belongs to the straight-haired Southern Mongolian group. This strain is called Proto-Malay, since the present Malay peoples are descended from it, after modification by mixture with the wavy-haired Indonesians. Among the Malays in the Peninsula and also in Sumatra are tribes of different origin: there are the wavy-haired pygmy Sakai of the same race as the Pre-Dravidian tribes of India, and the Semang, who are also pygmies but with a very dark skin and woolly hair. These latter therefore belong to the same great racial division as the Negroes of Africa and are termed Negritoes. A closely allied race is found in the Andaman Islands. It is probable that such peoples once extended over

[1] Viz., the straight-haired, wavy-haired and woolly-haired groups. The map in Fig. 99 shows only the predominating straight-haired peoples in this region.

the whole of south-eastern Asia and the neighbouring islands, and it is possible that from such people the African Negroes have evolved.

The islands of this region are occupied by descendants of the same races, but on the whole, the straight-haired Proto-Malay peoples may be said to predominate.

Australia and the Islands of the Pacific.—From the point of view of the distribution of races, New Guinea marks the approach to the islands of the Pacific (including Australia), for it is inhabited by a race distinct from those of Asia, and when we have added this people of New Guinea to those already considered, we have all the elements from which the populations of the Pacific islands have developed.

The inhabitants of New Guinea, called Papuans, may be seen from the maps to be in the main woolly-haired with long skulls. This combination of the two chief indications of race suggests that they should be classified with the Negroes ; this is confirmed by the projection of the lower part of the face, the flatness of the nose and the very dark colour of the skin, although their average height is below that of the Negroes. The Papuans probably inhabited a great deal of the region around New Guinea in the remote past, and with them the Negritoes, with whom, of course, they are to a certain extent akin ; probably some blending of their characteristics also took place. Thus a people belonging to the woolly-haired race seems to have spread from the region lying to the north of Australia, through the eastern portion of the greater Australia which existed in those days, and so by land to what is now the island of Tasmania. Here their descendants lived till long after the annexation by Europeans. The Tasmanians have only recently become extinct, and their physical characteristics are shown on the maps ; it will be seen that in the important matter of hair texture and skull-form they were similar to the Papuans and Negroes, but differed from the wavy-haired Australians.

The map in Fig. 99 shows that Australia is now occupied by wavy-haired natives, and so it is evident that if these woolly-haired ancestors of the Tasmanians once occupied Australia, they must have been displaced by a wavy-haired people, and most

probably these were of the Pre-Dravidian race, who also came by way of the Malay region. The differences between the Australians of the present day and the Pre-Dravidians of India and Ceylon have been accounted for by modification due to their different environments. Speaking of some of the Australians, Professor Gregory says: "During life in the Central Plains they became specialised to suit desert conditions. The dry arid climate led to the development of muscular, thin bodies; the extreme glare may have led to the recession of the eyes . . .; and the scarce food led to the development of the teeth and corresponding increase in the size of the jaws." The population of Australia seems always to have been very scanty, probably only about 150,000 at the beginning of the European occupation. The present aborigines are estimated to amount to half that number.

The breaking down of the land connecting Tasmania with Australia would account for the isolation and survival of the woolly-haired Tasmanians, just as the much earlier breaking down of the land connecting Australia with other continents would account for the preservation of the Australian marsupial animals such as the kangaroo.

The Melanesians (who inhabit the islands between and including the Bismarck Archipelago and the Fiji Islands) are in the main like the Papuans, but in some physical characteristics and in their language show similarities to the Polynesians, who include the Maoris of New Zealand, the Hawaiians and the peoples of all the islands east of a line drawn between Fiji and Hawaii.

The constant trading and frequent migrations between the islands of Polynesia have resulted in a complete blending of the peoples into one type, and prevented the differences which would tend to arise if the islands had been cut off from easy inter-communication. These Polynesians are wavy-haired, tall (i.e. above 5 feet 8 inches in average height), with features decidedly European in type and with rather light brown skin. It is known that they migrated eastward into the islands of the Pacific (about the time that the Angles and Saxons migrated into the British Isles), and it is most likely that they are a

branch of the Indonesian race who have gradually worked their way from India through the Malay region and Melanesia. In Melanesia they left only slight traces in the physical characteristics of the aboriginal inhabitants, but caused them to speak their language, and after they themselves had passed on eastward this language remained, so that although the Melanesian islands from the Bismarck Archipelago to Fiji are inhabited by people who are akin to the Papuans on their west, the language is akin to those spoken in Polynesia on their east.

Northern Africa.—In respect of the races of people, as in respect of structure, climate and vegetation, the North of Africa is not distinct from the South of Europe, but with it forms one region. The Mediterranean race may be regarded as including the Semites and the Hamites, who together form the bulk of the population of Africa north of the Sahara.

The Semites have wavy hair, markedly long skulls, oval faces and fine features; from very early times they have inhabited the south-west of Asia, and within historical times have spread far to the west. The Arabs in particular have migrated, conquered and settled, reaching across northern Africa to the Atlantic and also far down the eastern portion of the continent.

The Hamites have a darker skin, usually less fine features and frequently "frizzy" (but not woolly) hair. These differences are possibly due to these people having originated in a mixing of Negro blood with a Semitic stock. To the eastern division of the Hamitic group belong both the Fellahin and the Kopts of Egypt, the Bejas between the Middle Nile and the Red Sea, and the Gallas and the Somali between the head-streams of the Nile and the Indian Ocean. To the western division of the Hamitic group belong the Kabyles and the other Berbers of the Atlas Lands, the Tuareg of the Sahara south of Algeria, and the Fulahs who are mixed with and dominant among the Sudanese Negroes.

To the same group must be assigned certain peoples who have a less pure descent. In the Atlas Lands the agricultural Berbers are Hamites, the nomadic Arabs are Semites, while the town-dwelling Moors are of mixed descent. The Abyssinians are also a blend of Hamitic and Arab elements. The Nubians on the

west bank of the middle Nile are a blend of Hamitic and Negro elements, as are also the Masai, who are found east of Victoria Nyanza.

Central and Southern Africa.—South and west of these peoples are the woolly-haired races, whose characteristics are most markedly shown among the Negroes described at the commencement of this chapter. The true Negroes are centred in the Sudan, and have extended north into the desert (see map in Fig. 99), and south to the coast of Upper Guinea; among these Negroes the Hausa nation between the Benue River and the Sahara is specially important.

There are also pygmy tribes inhabiting parts of the dense forests, mainly about 3° north and south of the Equator. These people, who are called Negrilloes, have an average stature of about 4 feet 6 inches; they are by no means black, but have a dark yellowish skin, and because of these and other characteristics are considered to have been originally akin to the Bushmen described below.

The centre and south-east of Africa are occupied by peoples having a Negro basis but exhibiting differences due to mixing with other stocks, e.g. with Negrilloes and Hamites in the north and with Bushmen in the south. They speak various dialects of the Bantu group of languages, and for this reason have been called Bantus, but it must be remembered that they are grouped only on a language basis and do not form a racial unit. They are usually shorter than the true Negroes and have not so dark a skin; also some typical Negro characteristics are frequently less marked, e.g. the flat nose. The include the Suahili, who live in Zanzibar and along the coasts opposite the island; and in South Africa there are three important groups. (i) In the centre and extending eastward as far as the Drakensberg Mountains are the Bechuanas, who include the Basutos; and in the upper basin of the Zambesi are the Barotse, who include the Mashonas. (ii) East of the Drakensberg Mountains are the tall and well-built Zulus, and a tribe of these, generally known as the Matabili, conquered and occupied that part of the territory of the Mashonas now called Matabililand. The general term "Kafirs" is commonly applied to the Zulu peoples and also to

those of the central group. (iii) On the west side of the continent are the Hereros of Damaraland and kindred tribes immediately to the north.

In and around the Kalahari desert are the Bushmen, who

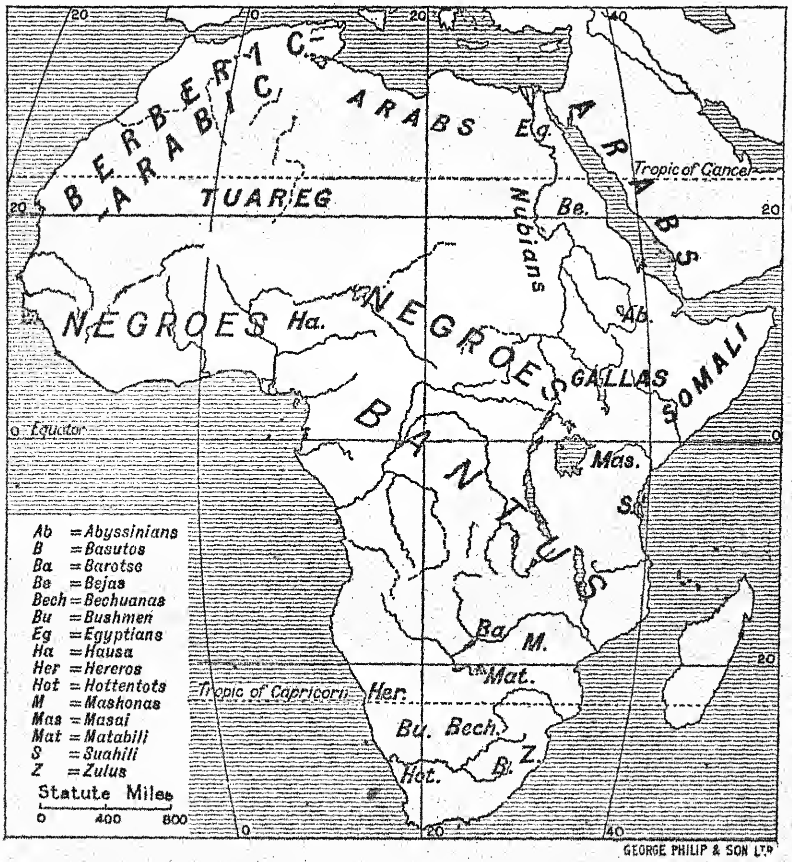


FIG. 102.—Peoples of Africa.

are very short and have skin of a yellow colour; their hair is short and gathers into tiny tufts, which give it a patchy appearance; they have very broad noses, and their cheekbones are prominent. Thus they must be classed with the woolly-haired peoples, but regarded as quite distinct from the Negroes. The

difference between the Bushmen and the Hereros is strikingly shown on the map showing the colour of the skin (Fig. 97).

In the better lands around the country of the Bushmen live still another people, the Hottentots, who have several characteristics which suggest thay have resulted from a blending of the Bushmen and the Bantus. The Hottentots have a yellowish skin of a brown tinge; they are intermediate in height; their hair is to some extent tufted and they also have prominent cheek-bones. The truest type of Hottentots are the Namaqua of the west; those of Cape Colony are now of mixed Hottentot and Bantu or Boer descent. The Bushmen and Hottentots previously inhabited the richer country of the east, probably as far north as Lake Tanganyika, but were driven south and west by the Bantus, who came from the Uganda region. Here, as elsewhere, the present position of the races is suggestive; in this case the strength or weakness of the various peoples corresponds closely with the richness or poverty of the lands thay have been able to occupy.

The effect of a blending of races resulting in the selection of the characteristics most useful in a particular environment is exemplified in the case of savage Africa by the fact that the most successful warriors are the tribes of mixed Negro and Hamitic descent, e.g. the Masai, and some of the Bantu peoples, notably the Zulus.

Madagascar.—The peoples of Madagascar are remarkably complex. Although the island is comparatively near Africa, it has been largely occupied by peoples who have come from South-east Asia, for the unindented coast of Africa has not encouraged seafaring, while the numerous islands of south-east Asia have developed peoples renowned for their seamanship. From the Malay region, therefore, both Madagascar to the west and Polynesia to the east have been colonized. The side of Madagascar facing Africa is inhabited by people of almost pure Bantu blood; in the centre of the island are the Hovas, mainly of the Indonesian stock; on the east side are the Malagasy, of mixed descent from the Bantu and Hova elements.

The Americas.—If the primary division of races is made according to the texture of the hair, it is evident from the map in

Fig. 99 that the whole of the native peoples of the Americas are to be classed with the Mongolians as being straight-haired. This classification is strengthened by the fact that in respect of skin colouration yellowish shades[1] are found widely distributed. Yet an examination of Fig. 100 shows that differences of skull-form are very great, and that over considerable areas the people are long-skulled. The fact that the tribes vary in height from the very short peoples of Labrador to the very tall Patagonians is also significant.

These considerations make it necessary to suppose that if the original stock was akin to the Mongolians, great differences have evolved in the greatly differing environments. It is therefore clear that an immense time must have elapsed since the continent was first populated, and that the natives are now not of one type but of many types.

For four centuries there have been immigrations of Europeans, and this influx has become much more rapid during the nineteenth century; also, to obtain slave labour the Europeans introduced Africans.

These peoples have almost entirely displaced the natives in Canada and the United States, and a large proportion of the population of Argentina, Chile, and Brazil are European in descent. In these latter states and in most of the remaining countries there has been a great admixture of the European and native races, for example, nearly half the people of Mexico are of mixed descent (the "Mexicans"). Only in Central America, Ecuador, Peru, and Bolivia are the majority of the people of native descent, and taking the whole of the two continents into account the intrusive peoples outnumber the aboriginal peoples many times over.

Moreover native races in most cases tend to die out after contact with Europeans,[2] owing partly to the disappearance of

[1] Although the skin colour of the people in different parts of the Americas may be called "yellowish," "brownish," or "yellowish brown," it is misleading to use the term "red"; the natives of America are neither "red" nor "Indians."

[2] The Negro peoples are exceptional in this respect, probably because the woolly-haired and wavy-haired peoples have been in contact in Egypt and other parts of Eastern Africa for thousands of years.

their accustomed means of livelihood under the new conditions, partly to the adoption of new vices (notably drinking of spirits), and still more to the spread of newly-introduced diseases. These are much more fatal to the natives than to the Europeans, many of whom are completely or partly immune: for example, measles spreads quickly with terrible and fatal results, small-pox destroyed three and a half millions in Mexico in the first epidemic of this disease in the sixteenth century, and consumption has proved the greatest scourge of all. On the other hand, medical science and sanitation are now making rapid strides in enabling white men to live in tropical countries, and to take one instance, it is found that malaria can occur only when the germs are carried by a certain kind of mosquito, and that by the draining of the swamps both the mosquito and the malaria can be exterminated.

Since the native races of America are thus of comparatively little importance in the modern world, it is unnecessary to study them in detail. It may be pointed out, however, that the Eskimo of the far north are in most respects like the Mongolians, and among them alone of the natives of America is the Mongolian eye common, yet the fact that they are long-skulled will not allow them to be completely identified with the broad-skulled peoples of northern Asia.

RELIGIONS

Primitive Forms.—Many early and crude forms of religion remain in those parts of the world to which later forms have not penetrated. Some of these primitive forms may be grouped under the name of *animism*, which denotes a belief that all living and non-living objects have souls; thus water, the sky, the trees and animals are thought to have spirits which must be worshipped. One development of this belief is *fetichism*, notably held by Negroes, which regards some particular objects as being inhabited by special spirits; hence the object, perhaps a stone, may be carried as a protection or propitiated by sacrifice. This leads to *idolatry*, in which the idol is not considered as the habitation but only as the image or representation of the spirit that is worshipped.

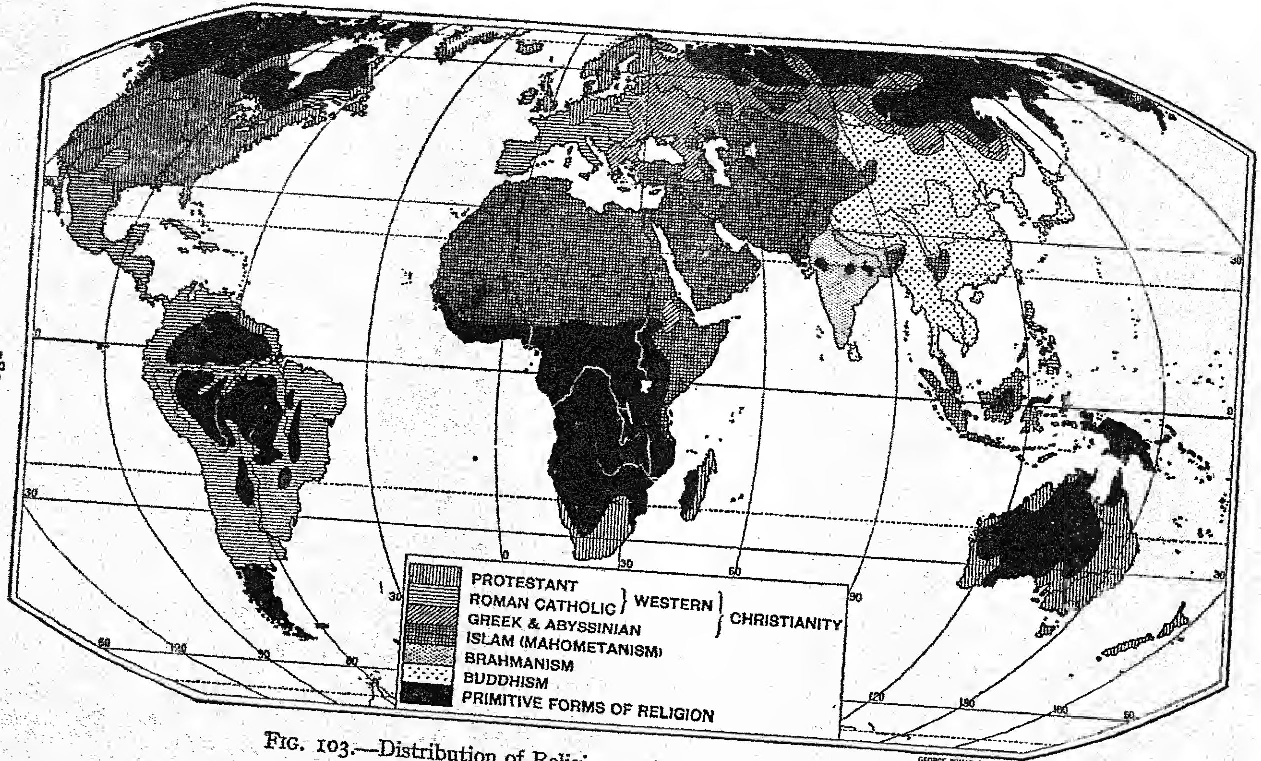


FIG. 103.—Distribution of Religions. (Based mainly upon Gerland.)

As some men were thought better able to communicate with the spirits than other men, these became the fetich men or shamans, whose aid is invoked by the people on all important occasions; in this way a class of men became separated from the remainder and endowed with great power, and thus a definite priesthood evolved.

Brahmanism.—Among the Aryas of India, the priests formed a very definite and hereditary group or caste; the priests were Brahmans, and the religion was therefore called Brahmanism. In this system, which is at the same time religious and social, there are three other great castes: the warriors, to whom the Rajputs belong; the farmers, who also have some standing; and finally the lowest caste, who are held by the others in great contempt. Moreover, there are many sub-divisions of these castes, and each is associated with a particular occupation which is hereditary. The religion became debased, and is little more than a tangle of superstitions associated with many gods and a multitude of rites, many of which are meaningless or objectionable.

Buddhism.—About 600 years B.C. a prince of the warrior caste, by name Gautama, lived near the Ganges. He withdrew from the degenerate forms of Brahmanism and taught a way of life that was both simple and pure. His followers called him Buddha, i.e. the Enlightened One, and the religion that has grown from his teaching is called Buddhism. It holds that the souls of men pass after death into other bodies, which are of a higher or lower type according to the merits of the soul, and it finds the reward of supreme virtue in "Nirvana" or the complete cessation of life. It is a sad faith, and one which leads its followers to a quiet and kindly life.

Buddhism has spread far over South-eastern Asia, but it has been driven from the greater part of India by Hindu (that is, later Brahman) devotees and by Mahometan conquerors, surviving only in the mountains of northern and eastern India and in the island of Ceylon. Its stronghold is now China, where, however, other religions are also professed.

Religions of China and Japan.—About the period when Gautama lived in India, Confucius taught in China; he was the exponent of a religion which existed even before his time, so

that the Confucianism of China of to-day dates back very far. According to this religion, Heaven (the clear sky) is the supreme deity, and in addition spirits of many kinds are worshipped, including the spirits of ancestors; the reverence and worship of ancestors is the most characteristic feature of Chinese piety. A third religion of China is Taoism, an indefinite body of teaching of a high order of morality.

As in China, so in Japan several faiths exist without clashing; indeed people may claim adherence to them all at the same time.

In Japan, Buddhism has the greater number of adherents, but the oldest religion is that of Shinto, the Way of the Gods; one of the gods is the Mikado, or Emperor, who is regarded as being descended from the sun-goddess.

Christianity.—More modern than any of these religions is Christianity, which has been adopted by most of the more civilized peoples. Having its root in Judaism, it spread widely over Europe in the course of a few centuries, and became so organized that the bishop of Rome had precedence over the other patriarchs. In the eleventh century, however, the Greek or Eastern Church was permanently separated from the Roman or Catholic Church.

After the close of the middle ages, the nations of north-western Europe broke away from the supremacy of the Pope, and a number of Protestant churches were formed. With the migration of Europeans to newly-discovered lands, these two faiths of western Europe were established in the New World, the northern peoples establishing their Protestant faith over the greater part of North America and Australasia, while the southern peoples have extended Roman Catholicism over Mexico, and Central and South America.

Mahometanism.—Mahomet was born in Arabia about six centuries after Christ. He consolidated the worship of the many gods of the Arabs into that of one God, Allah, and wrote his teaching in the sacred book, the Koran. The religion, which he called Islam, owed much to both Judaism and Christianity, but Mahomet became very hostile to both Jews and Christians. Mecca was made his capital, and from that centre he commenced to spread his religion by the sword. His successors within a

few years conquered Syria and Persia, and then spread the faith far into Central Asia and over the whole of northern Africa, and even into the Iberian and Balkan peninsulas of Europe. Warfare against non-believers was a precept of this religion, and under the stimulus of their faith warlike peoples of the deserts and their margins seriously threatened the existence of Christian Europe during the latter part of the middle ages.

AUTHORITIES AND BOOKS FOR FURTHER READING.

A. C. Haddon: *The Races of Man* (Cambridge Press).
R. R. Marrett: *Anthropology* (Home University Library).
J. Huxley and A. C. Haddon: *We Europeans* (Jonathan Cape).
H. J. Fleure: *The Races of Mankind* (Benn).
V. G. Childe: *Man Makes Himself* (Watts).
E. E. Kellett: *A Short History of Religions.*
E. von Eíckstedt: *Rassenkunde and Rassengeschicte der Menschheit.*
R. Benedict: *Race and Racism.*
E. Plant: *Man's Unwritten Past.*

CHAPTER XIII

INDUSTRIES

The various industries by which men live are controlled partly by the physical conditions of their environment, and partly by the character of the people. Conversely, the industries in the long run lead to profound modification and development of the habits, customs, and even minds of the people, and in some cases cause changes in the region itself.

The simplest way in which people may get a living is by the mere gathering of such vegetable products as grow wild. It is a step onward to the hunting of animals and catching of fish; these occupations demand intelligence, and skill in the use of weapons, and in turn lead to the improvement of these characteristics in the peoples who engage in them, for only those people who have the requisite qualities survive, the struggle for existence eliminating the others.

A much more important step is taken when animals are bred and reared; this pastoral work requires and ensures such qualities as forethought, care, and power of co-operation.

Agriculture similarly demands valuable qualities in man; under favourable conditions it repays his work by an abundant return which gives him both materials and leisure to cultivate various arts and crafts, and by giving him a settled home instead of necessitating a wandering life, it makes possible many advances.

In the same way mining, manufacture and commerce depend upon and encourage civilization, and in the last century or two have been intimately bound up with the progress of science. They have led also to the aggregation of people into great cities, and thereby given rise to serious problems; while certain nations which have possessed special facilities for these industries have

increased greatly in population and wealth, and extended their dominion over large areas previously occupied by less advanced peoples.

GATHERING OF VEGETABLE FOOD [1]

The most primitive occupation is that of gathering such food as fruits, nuts, berries, and even roots of plants. Such work often supplements other means of obtaining a livelihood, but it is now very seldom the staple occupation of a people. Only the most backward peoples depend largely upon it, and it is pursued mainly by some few American Indians of the Amazon valley, the Fuegians, the Negrilloes of Central Africa, the Bushmen of South Africa, and the aborigines of the almost desert portions of Australia.

Such peoples obtain a very poor living, except perhaps in the equatorial forests where plant growth is luxuriant, and their manner of life leads to no advance in civilization; they tend therefore to disappear before other peoples who encroach upon their country.

FISHING

Fish form a valuable food, and fishing is therefore an industry pursued by all peoples, from the most primitive to the most advanced, who have access to waters.

Sea fishing is carried on to the greatest extent off the "drowned" coasts where the submerged continental shelf forms the fishing grounds, and the inlets afford shelter and harbours.

Few peoples are exclusively fishers; the Eskimo are exceptional in this respect, for the scarcity of vegetable life and land animals forces them to satisfy most of their needs from the sea. Elsewhere among somewhat primitive peoples other means of livelihood are also pursued, such as gathering vegetable produce or hunting animals, and when agriculture can be practised this supplements fishing. In the latter case, the men may be the fishers while the women remain by the dwellings and carry on

[1] The map in Fig. 104 should be constantly referred to as this chapter is studied, and compared with the other maps, especially those showing climatic conditions and the distribution of vegetation.

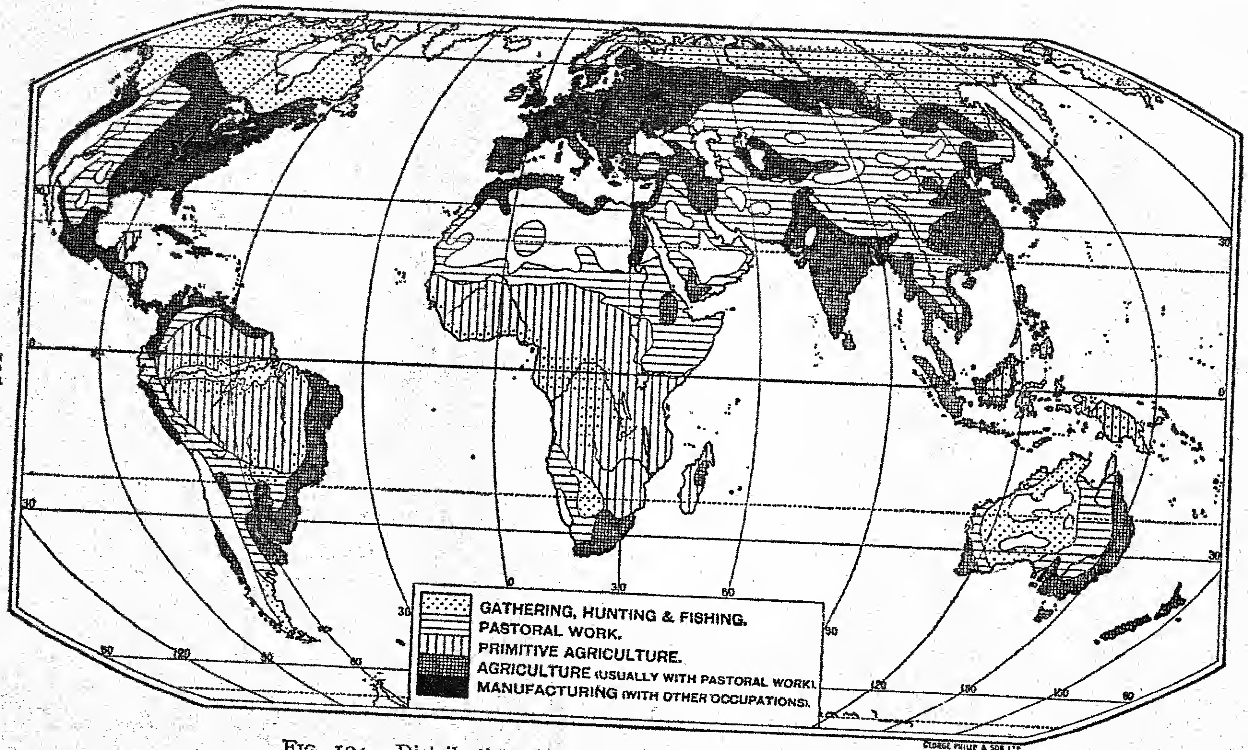


FIG. 104.—Distribution of Occupations. (After Oppel and others.)

the agriculture. The seafaring necessitated by fishing encourages the discovery of other lands, and migration; thus, as shown in the preceding chapter, the people of the Malay Peninsula and Archipelago, who have always been fishers, have spread both to Madagascar and Polynesia, and the Scandinavians, another fishing folk, seem to have reached North America about 500 years before Columbus. The instance of the Scandinavians serves to illustrate the fact that fishing also encourages trading, for even now they have a merchant navy exceeded only by Britain and the United States.

Among the more advanced peoples, fishing is an organized industry. The fishers from certain centres go out to fishing grounds, often to a considerable distance, whence the fish may be brought back by steam vessels and despatched by railways to the great cities. Where the fish are obtained at greater distances from a market they are cleaned, then dried, salted or tinned, and thus preserved are sent perhaps half around the world.

The most valuable fisheries are those of cod, a fish which, with the herring, lives in the cold waters of high latitudes, and is obtained mainly from the Scandinavian fishing grounds and the Newfoundland Banks. The chief fish caught in rivers is the salmon, largely obtained from the western portion of North America, and particularly in the Columbia and Fraser Rivers and those of Alaska.

There is a steady increase in the quantity of fish caught, and at present the countries whose fishermen obtain the greatest amount are the United States, Britain and Russia.

HUNTING

Wherever wild animals live, there hunting takes place. In earlier times a large proportion of the habitable land was occupied by hunting peoples; but now the extension of other industries has restricted it mainly to the tundra, the poorer grass and scrublands which have not been utilized for pasturing and agriculture, and all the forests which have survived destruction.

Usually it is necessary for the hunters to move constantly from one district to another to obtain a sufficient supply of game; their livelihood is precarious, and frequently the struggle for

existence is very severe. Under these conditions, hardihood, strength, and swiftness must characterize the men; and in order that they may be able to make the great exertions that hunting intermittently demands, they leave to the women most of the other work, heavy though it may be, such as carrying the burdens when the family migrate, preparing the food, and making skins into clothing and tent coverings. The families frequently live separately, for large communities are of little advantage when hunting is the chief means of living. Each man requires to hunt over a considerable tract of country, and consequently other men are regarded as rivals; a feeling of hostility is easily aroused, and the constant use of weapons tends to make warfare common. Hunting tribes are nearly always warlike, and may combine to attack and plunder more settled peoples near whom they live.

The hunting of furred animals is carried on in the forests of higher latitudes by hunters of the more advanced races, who exchange the skins for the products of other regions. The Russian Soviet Union and Canada, which have extensive coniferous forests, are the chief countries which export furs.

PASTURING

The transition from hunting wild animals to the breeding and rearing of certain herbivorous ones, marks a great advance in the history of mankind. In the first place, the pasturing of animals places at man's disposal the means of satisfying practically all his necessities; from the reindeer the dwellers on the tundra can obtain food, clothing, and shelter, while still more varied is the produce of the sheep, cattle, goats, horses and camels which are reared by the pastoral peoples of the grasslands and semi-deserts.

Among primitive peoples, pastoral work demands care, skill, and forethought; it is carried on most successfully when a considerable number of animals are kept together, and this demands the constant co-operation of many persons, and so leads to the adoption of a closely-knit tribal organization which again paves the way to higher social and political communities. The living is somewhat precarious, for drought, cold or disease may work havoc with the flocks and herds; but when large numbers of

animals are reared it is very seldom that even in the worst years all are destroyed, and at better periods an abundant supply of the necessities of life is obtained. Indeed, a surplus may usually be looked for, and the skins, hair, and wool may be made into clothing, rugs, and mats in which the beginnings of art are frequently expressed. These commodities may be exchanged for others produced by agricultural, mining or manufacturing peoples.

The life must, however, be migratory, and this limits the acquisition of property, except in the form of the flocks and herds which sometimes become very large. The need for fresh pastures is one reason for the nomadic life; another is the marked temperature change from summer to winter which necessitates a migration into a different climatic environment. Thus the tundra tribes move northward in the summer to take advantage of the fishing in the open sea, and southward in the winter to the forests, where they are sheltered from the rigours of the weather and may hunt furred animals. The people of the grasslands are controlled in their wandering partly by their need of water, so that they follow the streams or go from well to well, and partly by the changes of temperature which allow them to utilize the uplands in summer and drive them to the valleys and lowlands in winter.

The nomadic life causes them to live mainly in tents, and prevents the use of heavy or bulky furniture and utensils; these are therefore of the simplest kind, and largely made from the produce of their flocks and herds.

The grasslands of the world are now being occupied by peoples who have passed through this simple stage of civilization; in several regions Europeans have settled, either practising agriculture alone, or combining this work with the rearing of animals, or in the more arid portions, giving themselves exclusively to pastoral work. They have, however, settled dwellings, making use of their increased knowledge and resources to provide water (possibly by deeper wells than primitive peoples could dig) and shelter for the animals. They live to a much less extent on the direct produce of their work; they send away to other lands either live animals or meat preserved by salting, tinning

or freezing, together with the hides, skins, and wool, and receive in return manufactured goods and even much of their food and clothing.

In lands in which agriculture is largely carried on, pasturing also finds a place. Thus in England much of the land on the relatively dry limestone and chalk ridges is given to sheep-rearing, while cattle feed on the richer meadow-grass of the lowlands. Where agriculture and pastoral work are combined the industry is termed " mixed farming."

The largest supplies of wool and hides are obtained in the semi-arid regions of Australia, the grasslands around the River Plate in South America, the western plains of North America, the South African veldt, New Zealand, and the European steppes. The flesh of the animals is in some cases consumed at home; the countries which export the greatest amount of cattle and meat are Argentina, Uruguay, Australia and New Zealand.

AGRICULTURE

Primitive Agriculture.—In clearings in the equatorial forests and on their margins, primitive forms of agriculture are carried on. Thus with but little labour maize has for very long been grown in equatorial and tropical America, particularly in the higher regions. In the Amazon valley tubers and roots, such as the manioc (from which cassava and tapioca are obtained) and sweet potatoes, give a rich return for the slightest amount of cultivation, the work, indeed, often consisting of nothing more than the planting of shoots in the river alluvium. In Africa bananas, and millets and other cereals are grown by the negroes, who in the central parts are agriculturalists as well as hunters and gatherers; in the savannahs of the Sudan and East Africa pastoral work is combined with primitive agriculture. In the East Indies bananas, yams, and sweet potatoes are cultivated together with the sago palm and rice, which have assumed great importance; in the Pacific Islands the coco-nut palm is the chief product.

Advanced Agriculture.—The practice of agriculture tends to produce several important results. With gradual improvements in methods of cultivation and the introduction of new

plants a constantly increasing knowledge and skill are acquired, assuring a greater command over nature and a more abundant satisfaction of man's needs. Settled dwellings may be constructed, and stores of food preserved. Thus the material bases of civilization come into existence, so that the earliest civilizations grew up in the rich agricultural regions of the Nile, Tigris and Euphrates, and the Indus.

Although the increase of knowledge and skill releases the stringency of the control of man by nature, yet even in the most advanced societies agriculture must be carried on conformably with the requirements of the plants. Thus in the regions naturally covered by the broad-leaved forests of temperate latitudes men grow a considerable variety of useful plants; they have already largely substituted cultivated grasses (e.g. wheat) for those previously covering the grasslands, and as knowledge increases they will make greater use of the equatorial forests.

The particular use made of any locality depends partly upon such physical factors as the rainfall, the temperature (particularly in the growing and ripening periods), and the soil, and partly upon the human factors such as the supply of sufficiently skilled labour and the organizing of trade and transport. The conditions which determine the cultivation of the most important crops need consideration in some detail.

Wheat.—Wheat is primarily a product of temperate latitudes, the conditions under which it is most successfully grown being well exemplified by those of Central North America, particularly in the Prairie Provinces of Canada, and the eastern portions of North and South Dakota in the United States. As the wheat grown here is sown in spring, the winter temperatures are immaterial; the mean temperature for July, when the wheat is ripening, is about 20° C. Similarly, the conditions respecting rainfall are more important during the comparatively short life of the wheat plant than before or after; during the first part of its life the wheat requires a moderate amount of water, but when it is ripening, sunny weather is desirable. Since but little rain is necessary, wheat is frequently grown almost on the margin of cultivation adjoining arid regions, and where facilities for its

marketing are provided, its growth is being extended over the steppe-lands of the world. In many parts, the region beyond the farthest cultivation of wheat is used only for grazing purposes. Where water can be obtained from rivers flowing from highlands, irrigation is used for wheat growing in adjoining arid or semi-arid regions, as near the Rockies in North America. In western Europe the limit of cultivation is set, not by a lack of rainfall, but by an excess; the chief reason why only the east of the British Isles grows this cereal to any extent, is that the more western portions have rather too much rain, especially in the ripening season; only in the far north and on the highlands is the lower summer temperature a prohibitive factor.

An examination of the map showing the distribution of wheat cultivation (Fig. 105) and a comparison with those showing rainfall and temperature conditions, suggests that as far as climatic factors are concerned, the southern part of Siberia, Manchuria, and the north-east of China might be more important sources of supply; here the economic and political factors are those which at present limit the extension of cultivation, for example, the incomplete settlement and the difficulty of transport in Siberia and Manchuria, and in China the utilization of the ground for other products which the Chinese demand instead of wheat.

As much the same amounts of heat and moisture are required by the wheats grown in different regions, the time of growing has to be adjusted to the varying climatic conditions. Thus in the Mediterranean region the springtime is the growing period, and the harvest is reaped in May or June, whereas in North Russia the sowing is later and growth takes place more slowly, so that harvest comes at the end of August. A greater difference in the time of harvest is found in the case of Indian wheat which has to be grown in winter, when the temperature of the ripening period (February or March) in the north of India is approximately that of the summer in Manitoba. As the winter is the dry season in India, much of the water has to be supplied by irrigation from the streams flowing from the mountains. Moreover, since the harvests in the temperate regions of the southern hemisphere come in their summer time, i.e. from November to January, wheat is reaped throughout the year in

some part of the world. This is an advantage to those countries, notably Britain, which import much of their wheat, as it ensures a steady supply, and minimizes the effects of bad weather in particular areas. Thus if the harvest in one region fails, e.g. in Argentina, another crop which quickly follows may come from an entirely different region, e.g. India, and may therefore be quite successful.

At the present time the greatest wheat-producing countries are Soviet Russia, the United States, China, India, Canada and France, and other regions which have great harvests are the inner plains of extra-tropical Australia and the central region of Argentina; all of these (except India and France) being among the richest of the temperate grasslands.

Barley.—Although barley is a rather hardier plant than wheat and in parts is grown in colder and also in drier regions, yet its cultivation is carried on to the greatest extent in the wheat areas, so that the map in Fig. 105 would need but slight modification to show the distribution of barley.

The use of wheat is superseding that of barley as a breadstuff, and the latter is now, to a considerable extent, produced to obtain the malt for brewing. Russia, China and the United States are by far the greatest sources of supply, and are followed by Poland, Germany, Rumania, Spain and India.

Rye.—This cereal requires less heat than wheat, and can be grown on poorer soils; hence its cultivation extends in Europe to higher latitudes than the cultivation of wheat, and is most important over the plains of Central Russia and those on both sides of the Baltic Sea, and on the southern borders of the North Sea. It is mainly employed in making a "black" bread which is cheaper than that made with wheat, and is largely eaten in central and eastern Europe. Russia, Poland and Germany are therefore the countries in which the greatest amounts are produced; the cultivation has extended to North America only to a limited degree, and in the southern hemisphere neither the climatic conditions nor the demand for rye has encouraged its production.

Oats.—As wheat and barley are largely grown together, so rye and oats are closely associated, for their requirements are

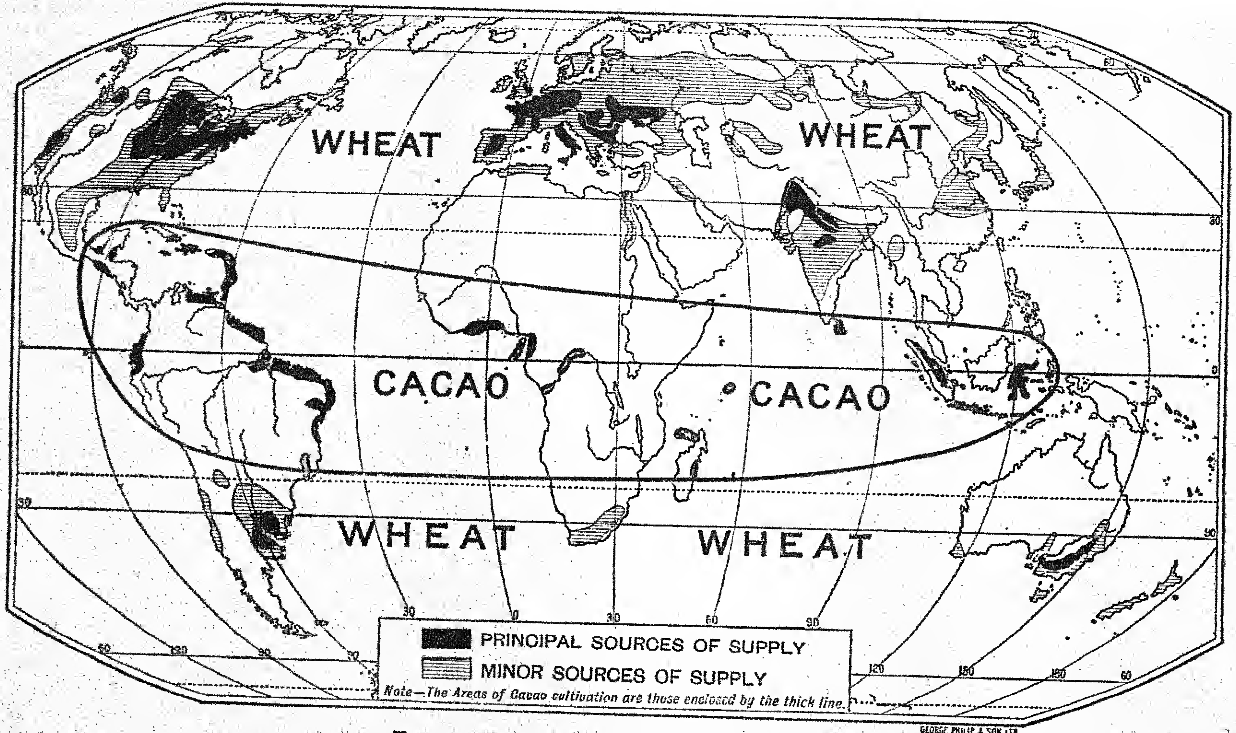


Fig. 105.—Distribution of Wheat and Cacao.

(Note.—Only the shaded areas within or without the thick line produce the commodity named.)

very similar. The differences that exist between the distribution of rye and that of oats are due to the differences in the demand for the products rather than in the requirements of the plants. Although rye bread is a staple article of food in much of the continent of Europe, rye has been abandoned in Britain and the United States as a breadstuff; on the other hand, oats are regarded as a valuable food for animals, and oatmeal for man. Consequently this crop is cultivated to a considerable extent in the United States, and in the north and west of the British Isles where the summer is too damp and perhaps scarcely warm enough for wheat cultivation. The chief oat-growing countries are the United States, Russia, Canada and Germany.

Maize.—Maize requires higher summer temperatures than wheat, and a comparison of the maps showing the distribution of the two cereals illustrates this fact (Figs. 105 and 107). It will also be observed that maize has a very wide range; it is grown in all latitudes from about 50° north to about 40° south, the difference in the heat of the regions being lessened by the higher altitudes at which the plant is usually grown within the tropics. The plant was brought from America by Columbus, and its cultivation has been very widely and thoroughly adopted; it is known by a variety of names: "Indian corn," "corn" (in America), "Turkish wheat" (in Hungary), and "mealies" (in South Africa) are some of these names. One reason for its wide extension is the prolific yield, an acre of maize giving twice as much grain as an acre of wheat; another reason is the varied uses to which it is put. It forms a nutritious human food, especially in the United States in the form of "cornflour" and "hominy," in Italy where "polenta" is made from the meal, and in Spanish America. To an even greater extent it is employed as a food for cattle, and the great pork and beef packing industry of the United States is located in the centre of the "maize-belt" largely because the maize is the chief food for fattening the animals. Starch and spirit are obtained from maize, and it is put to a number of other uses.

In consequence of the great demand for this cereal, the total production is approximately equal to that of wheat, and of this total nearly three-quarters is grown in the United States, where

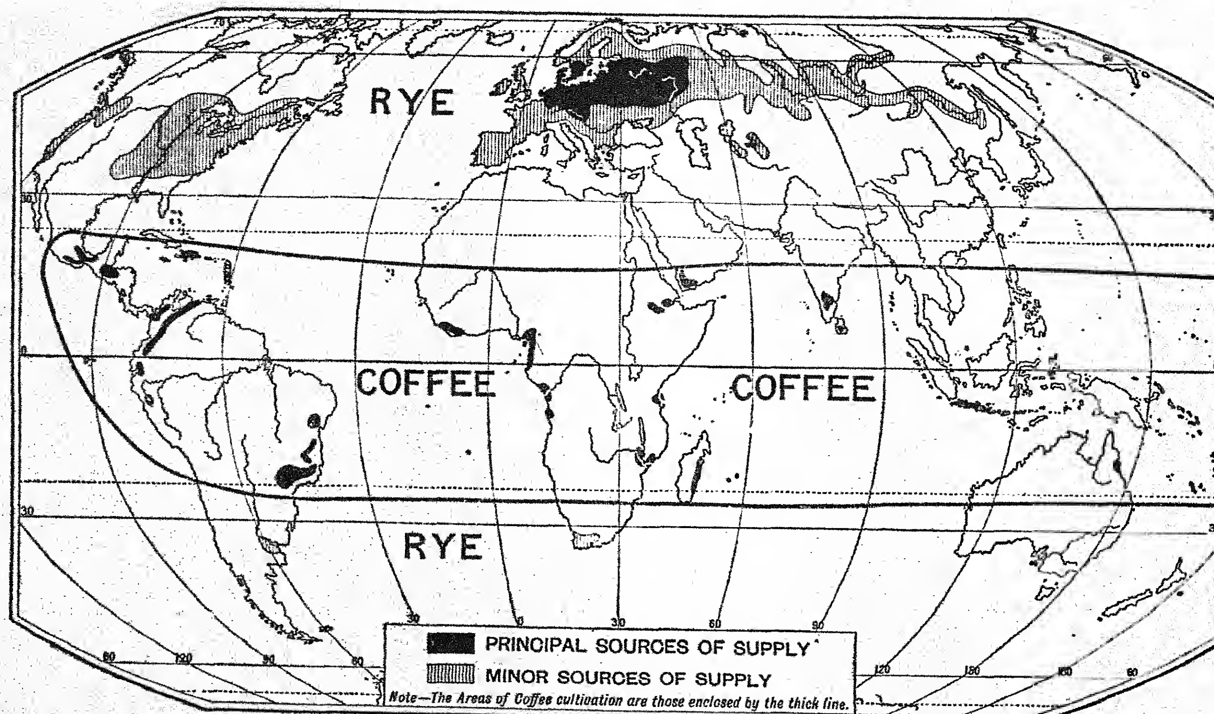


FIG. 106.—Distribution of Rye and Coffee.

it is by far the most valuable crop. A great increase in the production of maize has taken place recently in Argentina, and other countries where the cultivation is considerable are China, Brazil, Russia, Hungary, Rumania, Yugoslavia, Italy and India.

Rice.—The position which wheat occupies in temperate countries is taken by rice in warmer regions, for it is the chief food of about half the population of the world, notably in India, China, Japan, Siam, Burma, French Indo-China and Java. These countries are the greatest producers (see Fig. 110), and Burma exports to China and Japan as well as to Europe. The heat and moisture of the monsoon lands are very favourable to the cultivation of rice, which is grown mainly on the low grounds, plains and deltas flooded in the rainy season, though varieties known as "hill rice" which do not need flooding are grown in some upland districts. Over large areas two harvests a year may be obtained from the same field, but independently of this double-cropping the yield is very great in comparison with the amount of land occupied, so that these rice-growing regions support much denser populations than other countries where agriculture is the chief occupation. From the monsoon areas the cultivation has spread to many other parts of the world. In Africa the greatest production is in the delta-land of Egypt, annually inundated by the rise of the Nile, but the amount produced here is exceeded by that grown in the more northerly portions of the Mediterranean regions where the lowlands can be easily irrigated, especially the Plain of Lombardy. A considerable extension of rice culture has recently taken place in America, chiefly in the coastal and river lowlands in the south of the United States, and still more recently in British Guiana. The great food-value of rice makes it probable that still further developments will take place since, as the map shows, the possible area of cultivation may be so widely extended.

The Vine.—The vine has been cultivated in the Mediterranean region throughout historical times, and the map of its present distribution shows how it has been introduced into the other regions of the world with the Mediterranean type of climate (see

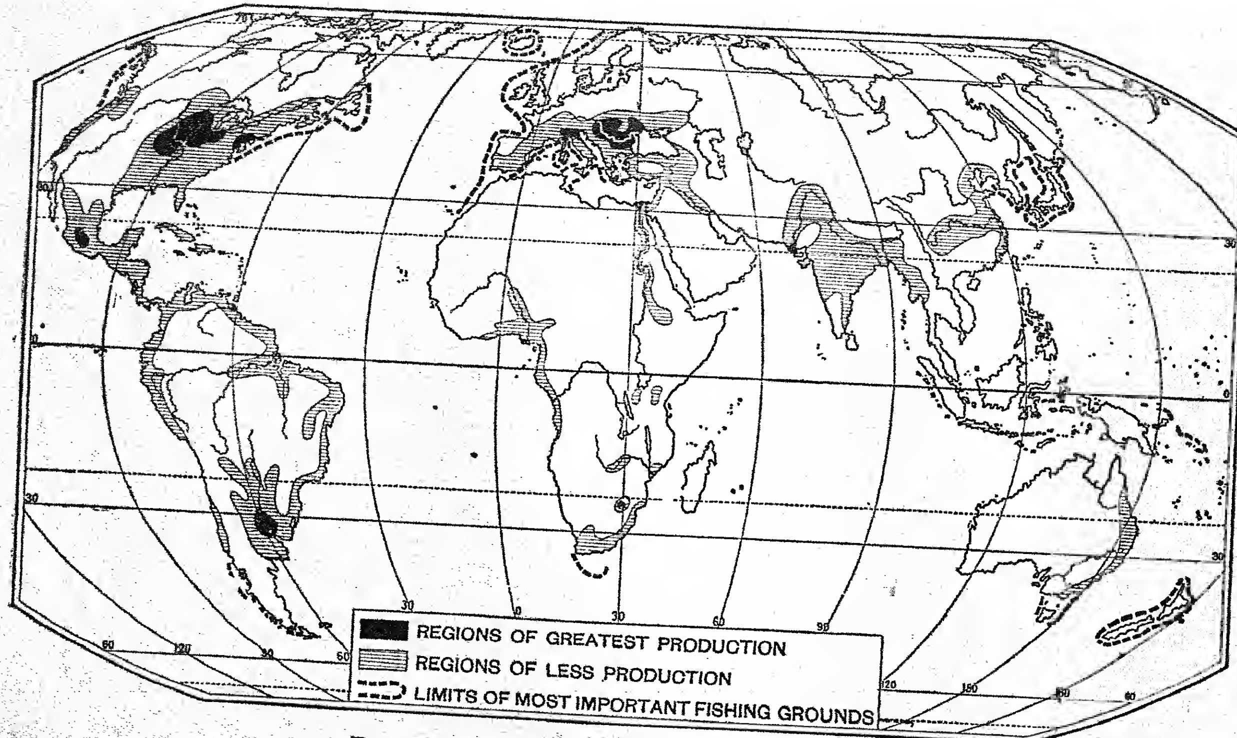


FIG. 107.—Distribution of Maize and Fishing Grounds.

Fig. 108). The vine which is cultivated for wine- and raisin-making is more exacting in its requirements than most plants. Moreover the yield is precarious, and good and bad seasons have marked effects on the production.

A summer of moderate heat but of long duration is needed for successful growth. This is obtained in regions of the Mediterranean type and south-central Europe, while in east North America, where the change from summer to winter is more rapid, the crop is inferior except in the neighbourhood of the Great Lakes which modify the change around their shores. In respect also of moisture, there are but narrow limits to the possible range: too much water makes the grapes watery and acid, too little causes them to be small and to contain too much sugar. A third control is the amount of direct sunshine; frequently the vines are grown upon terraces built on the valley slopes which face the south.

The fruit from the vines of the higher grounds is not so abundant as that produced in the lowlands, but it gives a wine of better flavour and therefore of greater value. Where the grapes are of a kind which yields poor wine they are exported fresh, as from the Iberian Peninsula, or dried. In the latter form they are known as raisins, which come chiefly from Asia Minor, California and Spain, the currants of Greece being made from a smaller variety.

Insect and fungus pests have caused great ravages in the Mediterranean region, France especially suffering from the phylloxera insect which came from North America and spread through the vineyards of almost every part. The remedy which proved most successful was to plant roots of the native vines of America, which had become immune to the pests, and upon these roots to graft cuttings of the European varieties.

Notwithstanding the great set-back which France thus experienced, it takes the first place in the production of wine, being followed by Italy, the Iberian Peninsula, Algeria, Rumania, Russia, Argentina and Germany.

Sugar.—Sugar is formed by nearly all plants as a reserve of food, and hence is obtained from various sources, but mainly from the juice of the sugar-cane, the roots of the beet and the

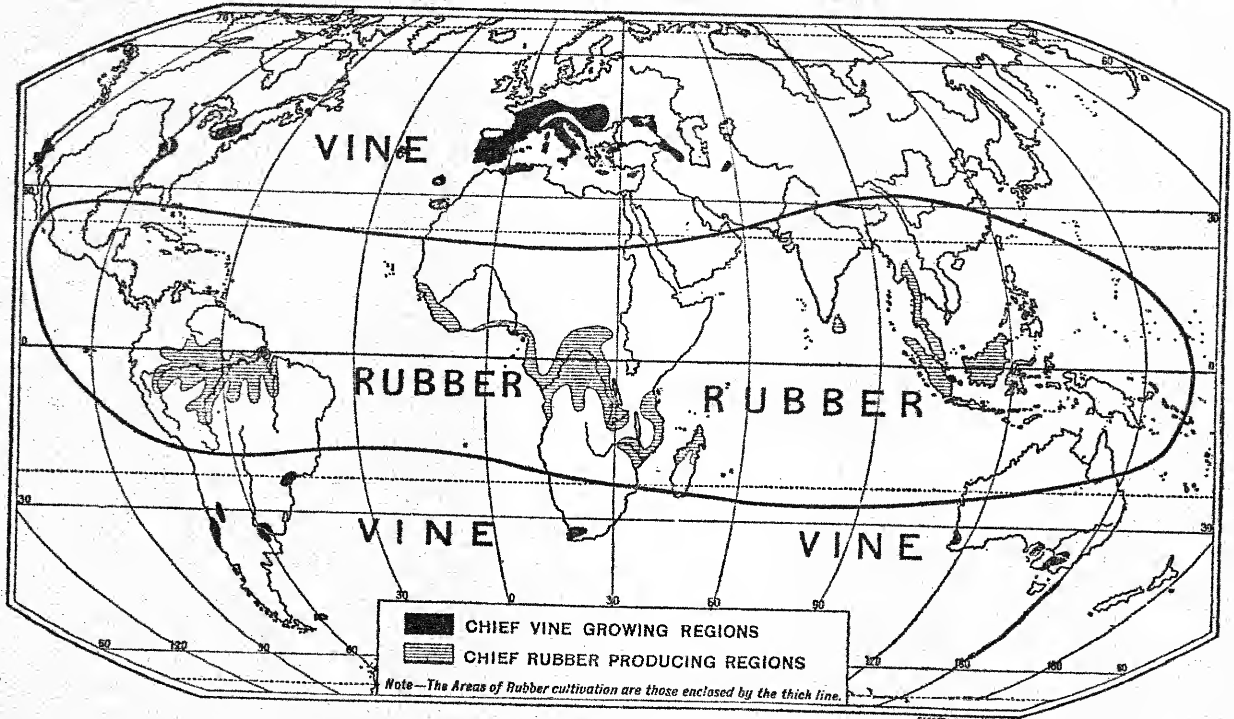


FIG. 108.—Distribution of Vine and Rubber.

sap of the sugar-maple. The last is grown only in Canada and the United States and is of comparatively little importance.

Until the nineteenth century beet-sugar was entirely negligible, but owing partly to the cultivation of kinds of beet which contain much more sugar than those first grown, partly to improvements in the methods of extraction, and partly to bounties given to the industry by several nations, the amount of beet-sugar greatly increased during the latter part of the century. The growth was most marked on the continent of Europe, for the climatic conditions which seem most favourable are those experienced in the transition belt between the marginal and continental regions. The greatest amounts of beet-sugar are produced in the United States, Germany, Russia, Czechoslovakia, France and Poland. In England there is a relatively small production in the eastern counties.

By the end of the nineteenth century the amount of beet-sugar which entered into the world's commerce far exceeded that of cane-sugar, but in 1903 an international convention put an end to the bounty system. The production of cane-sugar then increased so rapidly that by 1910 it exceeded that of beet-sugar, although the output of the latter had also increased.

The areas of beet and cane production do not overlap, for the cane needs a greater amount of heat. The maps showing the distribution of sugar-cane and rice exhibit a considerable correspondence, and this indicates a close resemblance in the physical conditions which these products demand; indeed, in Java rice and sugar are grown alternately in a definite rotation, though in most countries the sugar-canes are cut annually from roots which remain in the ground. Another similarity between rice and sugar-cane is the large return from a given area, land under cane yielding much more sugar than an equal extent under beet.

By far the foremost producing areas of cane-sugar are India and the islands Cuba and Java. Behind them come other islands:—the Philippines, Hawaii, Porto Rico and Formosa. The mainlands of the tropical and equatorial regions, in addition to India, produce smaller amounts.

The by-products of the manufacture of sugar are important.

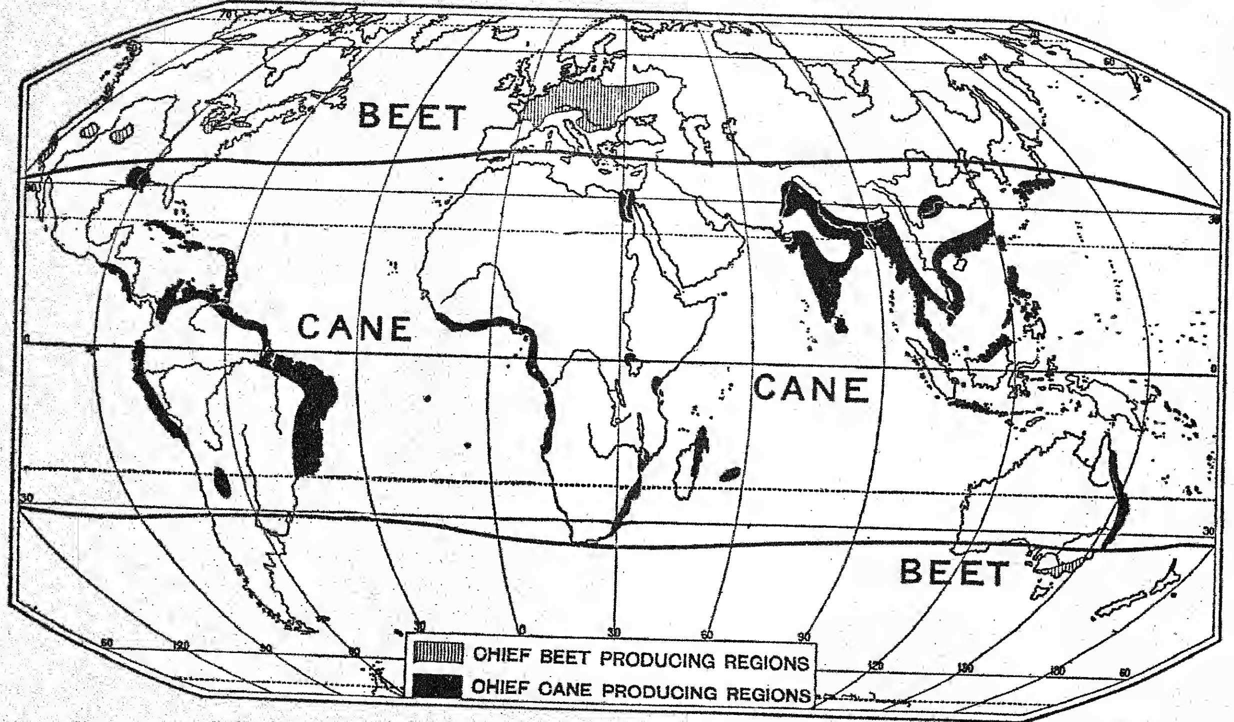


FIG. 109.—Distribution of Sugar Cane and Sugar Beet.

After refining the juice crushed from the cane both sugar-crystals and molasses (treacle) are obtained; from the molasses again alcohol for industrial purposes and rum are prepared. In the manufacture of beet-sugar, the sugar is extracted from the fragments into which the roots are cut by diffusion into water; from the juice so obtained crystals and molasses are produced, the latter yielding large quantities of industrial alcohol, while the pulp into which the fragments of beet are pressed is a valuable cattle food, usually returned by the manufacturer to the farmers who supply the roots.

Cotton.—The wide range of cotton cultivation (see Fig. 110) is in strong contrast with the fact that nearly two-thirds of the total production is derived from one region, the southern part of the United States; other countries which at present form a considerable source of supply are India, Russia, China, Egypt and Brazil.

The cotton-plant grows for six months before flowering, and after that the pods form and ripen; during all this period a moderately high temperature is required and an abundance of sunshine is equally necessary. Moreover, the moisture should not be excessive. These characteristics point to the sub-tropical rather than the equatorial or temperate regions as affording the best physical conditions for the growth of cotton, but it must be borne in mind that different varieties adapted to somewhat different conditions have been obtained, and thereby the limits of cultivation have been greatly widened.

The variety which is the most valuable, having long and silky fibres, is the "Sea-Island" cotton grown principally in the United States, but it should be noted that of the less valuable varieties the greatest production is not along the sea coast but some distance inland.

Also, it should be observed that in India the important areas of cultivation are those which have only a relatively small monsoon rainfall, the requisite moisture in the north-west of the Dekkan being partly obtained from the "black cotton-earth," a volcanic soil which has an extraordinary power of retaining water.

Similarly the Egyptian and Russian Turkestan areas have but little rainfall, for here as elsewhere the crop is a summer one, and irrigation is employed.

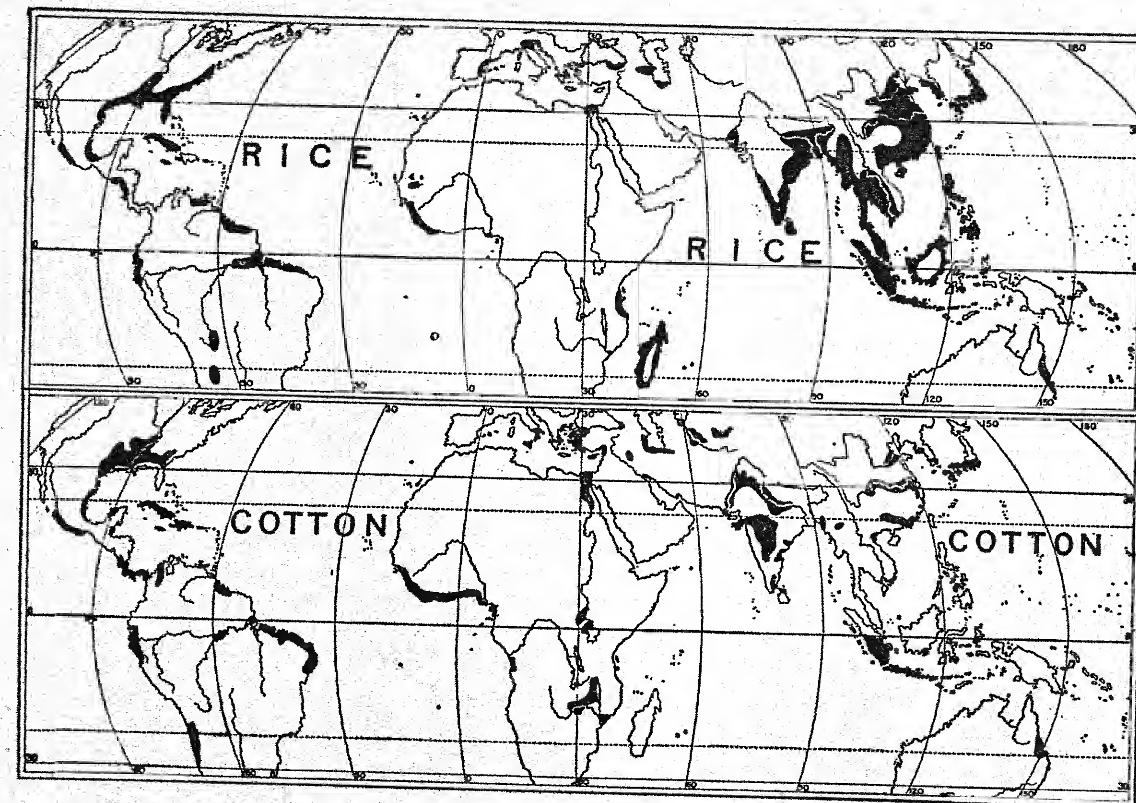


FIG. 110.—Distribution of Rice and Cotton.

An important factor in cotton cultivation is the necessity of considerable labour in tending the plant and picking the cotton; this necessity was a powerful incentive to the use of slave-labour in the southern states of America, and consequently an indirect cause of the Civil War of 1861–5 between the slave-owning South and the North, which had little need for slavery and desired its abolition. When the war cut off the supplies of raw cotton, the Lancashire manufacturers suffered severely, for they were very largely dependent upon this source of supply. At the present time, three-quarters of the import into Britain comes from the United States and most of the remainder from Egypt. Such a restricted area of supply is very harmful to the manufacturing industry, and so both private and public assistance is given to attempts at producing cotton in other parts, particularly in British colonies.

Cultivation in the British West Indies, once considerable, is being revived, and a similar process in going on elsewhere. In Uganda and the Anglo-Egyptian Sudan there is now a large production, and in Nigeria, British East Africa, Nyasaland and Rhodesia the prospects of development are encouraging. Australia, and more especially Queensland, is another region in which cultivation is taking place.

Tea.—Tea has been grown and used for centuries in China, and was introduced into Europe as a beverage in the sixteenth century. Its cultivation was extended into India and Assam in the early part of the nineteenth century, and afterwards into Ceylon, where it was grown to redeem the fortunes of the coffee-planters whose plantations had been practically destroyed by fungus pests. The attempt was successful, and tea was introduced into Natal for the same reason, but its cultivation has not there extended as it has done in India and Ceylon. Java and Japan are considerable producers, and a tea industry has been developed on the southern slopes of the Caucasus.

The tea-plant seems to require a warm climate and a considerable amount of rain, but (unlike rice) its roots must not have a great deal of moisture around them. Hence it must be grown in regions where the land is well watered and also well drained, and this condition occurs on the hillsides of monsoon

lands. The very considerable summer heat is tempered by the altitude ; thus the cultivation ranges to a height of about 6,000 feet and in some cases even to 7,000 feet.

The inefficient preparation of Chinese tea greatly injured its export trade, so that although great quantities are still produced in China, the export has now been exceeded by that from India, while that from Ceylon has become almost as great. Tea is also exported from Java and Japan but to a smaller extent,

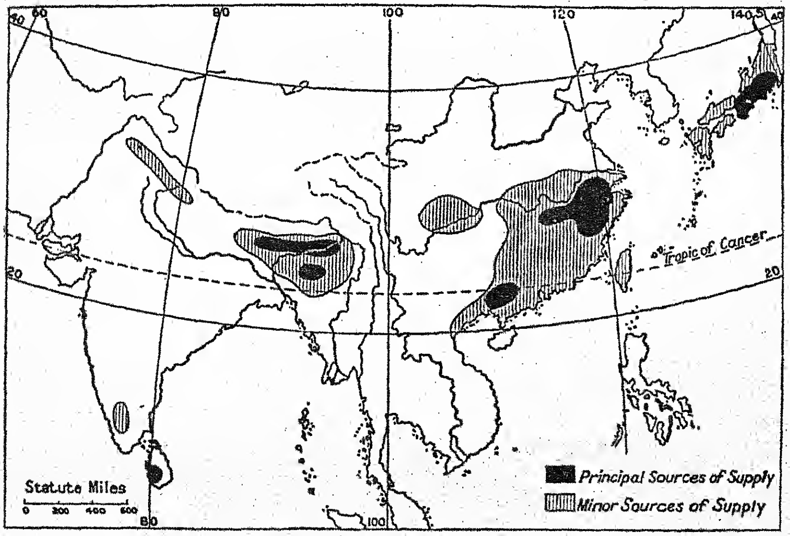


FIG. 111.—Distribution of Tea in South-east Asia.

and the exports from the Caucasus region and from Natal are still less.

Coffee.—The coffee plant requires climatic conditions somewhat similar to those required by the tea plant (see Fig. 106), but it is in most cases grown in rather hotter districts. Thus on the hills of Southern India, where both products are obtained, the coffee is grown at a rather lower altitude than the tea, and in no part of the world is coffee obtained in great quantity beyond the tropics, as the crop is injured by frost. It is mainly cultivated on high ground ; thus in Brazil it is largely grown at a height of between 1,000 and 2,000 feet and at about double this height in

Java as this is much nearer the equator. In many parts the coffee plants grow beneath others (for example maize, beans, bananas and plantains), which seem to be advantageous in such ways as affording protection from winds and preventing soil erosion even more than in shading the coffee plants from the sun.

Arabian coffee was introduced into Europe as a beverage in the seventeenth century and at the same time the Dutch commenced to grow it in Java. Much later it was taken to South America and there its cultivation has been most successful, so that nearly two-thirds of the world's supply comes from Brazil, the other states of Central and South America (especially Colombia and Venezuela) and the West Indies together producing much of the remainder. The Dutch East Indies furnishes a large supply, but Arabia is now unimportant.

Cacao.—Cacao, from the beans of which cocoa and chocolate are prepared, is a tree which needs very considerable and constant heat together with much moisture. It is therefore grown entirely within the tropics (see Fig. 105) and mainly close to the equator, the countries from which it is chiefly obtained being the Gold Coast, Ivory Coast, Nigeria and the island of São Thomé; Brazil Ecuador, Venezuela and the neighbouring island of Trinidad; the West Indies; Ceylon and Java. Moreover, it should be noted that the cacao is grown in the valleys and lowlands of equatorial regions, thus being distinguished from the coffee which is obtained from the highlands.

Rubber.—Rubber is obtained from the juice of several trees of the equatorial forests. At first the rubber was merely collected from the "wild" trees, but the enormous increase in the use of rubber led in some parts to a destruction of these rubber-yielding trees, and also to the planting of valuable varieties in promising localities. Thus seedlings taken from Brazil were planted out in Ceylon, and cuttings afterwards distributed to many parts of the world. Large plantations now exist in Ceylon and the Malay Peninsula and Archipelago, and the work is still being extended, although for a number of years the trees yield little or no rubber.

Brazil furnishes most of the small production of "wild" rubber, the Congo Basin being insignificant. Plantation rubber is

the main source of supply, coming principally from the Malay Peninsula, Dutch East Indies and Ceylon (see Fig. 108).

Flax.—This crop can be grown in the warm temperate parts of the globe, wherever the rainfall is not deficient. Russia has the largest production and the chief export of the fibre, but it is also grown in all the countries of Central and North-western Europe, including north-eastern Ireland. Owing to the lengthy processes involved in separating out the fibre, the crop is only profitable where plenty of cheap labour can be obtained. In hotter areas, such as South Russia, Argentina and India, the flax is grown for its seed; this forms the linseed of commerce from which oil and oil-cake are prepared.

Timber.—All the great forested regions of the world are potential sources of timber, but owing to the great bulk of this commodity only those forests are exploited which are conveniently situated for its transport and shipment. Firs and pines, which yield the cheapest woods, are obtained from the coniferous forests, chiefly those of Northern Europe and Eastern and Western Canada. Oak, elm, maple and beech are among the useful trees of the broad-leaved forests, and are obtained chiefly from the Eastern United States and from Central Europe. The tropical and equatorial forests yield hard and ornamental woods, such as teak from Burma, Indo-China and India, ebony from South-eastern Asia and Africa, rosewood from Central America and the West Indies, and mahogany from Central and South America.

Fruit.—The growing of fruit is usually an industry of only local importance except in the case of the hardier fruits which can bear transport without injury. Among these apples are a product of temperate regions with a sufficient rainfall, and are exported from the east and west of Canada, and the United States, and from South-western Australia and Tasmania. Oranges grow well in warm temperate or sub-tropical regions, especially those with the "Mediterranean" climate, and Spain, Italy, Palestine and California have a large export. Bananas are largely grown for local needs in many of the hot moist regions within the tropics, and are exported from the West Indies and the Canaries.

For authorities and books for further reading see bibliography at end of Chapter XIV.

CHAPTER XIV

INDUSTRIES—*Continued*

MINING

Physical Factors.—The greater part of the mineral deposits and especially those of metallic ores, were formed far below the Earth's surface and are therefore to be obtained mainly from the older rock-formations. Further, since the minerals must be both discovered and mined before they are of use to man, it is where the deep-seated rocks have been first up-folded and then exposed by denudation that mining is likely to be carried on. Consequently, the mining districts are usually in the neighbourhood of worn mountain regions. In some cases the old rocks have been only upheaved and denuded; in other cases they have been again covered by newer deposits, and this is frequently the case on the flanks of the folds or blocks of the older formations. In such cases the possibility of mining depends on the depth of the later covering.

The difficulty and cost of working increase with the depth for several reasons: deeper shafts must be sunk, there must be a longer haulage to the surface, and the greater heat makes the labour more difficult and ventilation becomes a greater problem. Hence, unless the mineral is a very valuable one or of exceptionally good quality, it is only profitable to mine at relatively small depths; it is very rare that a shaft is sunk to a depth of 5,000 feet.

Mineral wealth is unlike agricultural wealth in that it may be, and in the long run must be, entirely exhausted. The richer deposits will be first obtained and only the poorer ones remain until finally what is left is not worth mining. An improvement in methods of mining or in methods of extracting the mineral

from the ore may make it profitable to utilize deposits that formerly were considered worthless, but such improvements only postpone the end of the industry in any particular case. Thus the ultimate exhaustion of any actual working is certain, and so the mining industry in any place is of a more or less transitory character. Consequently the industries which are largely dependent upon mining must also be considered transient.

The existence and prosperity of mining industries in any particular locality are by no means entirely dependent upon geological factors. There must be facilities either for making use of the mineral in the immediate neighbourhood, or for transporting it to other parts where it is required. For example, if a deposit is far from materials with which the ore must be smelted and the metal extracted, and also far from a district in which the pure metal is needed for use, while at the same time transport from the neighbourhood of the deposit is costly, the deposit may long remain unworked even if known.

Human Factors.—Again, even where physical conditions are favourable, the people of a region may not undertake the work. They may be ignorant or incapable of the operations which are necessary; railways to connect the region with others may not yet be constructed; there may be a state of political unrest or bad government which deters people from investing the considerable amount of capital that is required for any extensive mining venture. Such difficulties are responsible for the fact that China has but little mining although its mineral resources are possibly greater than those of any other country in the world, and the Balkan Peninsula affords a similar instance of development retarded by the human factors. It was due to the human factors that mining only became a widespread and important industry as late as the nineteenth century although the use of minerals dates back for thousands of years, for the rapid development of the industry was connected with advances in the engineering and chemical branches of science, and bound up with the use of coal for smelting ores and working steam engines.

Fuels.—At the present time, the possession of supplies of coal is one of the most important factors in the mining and manufacturing industries of a country. Until nearly the end of the

nineteenth century, Great Britain was foremost in the production of coal, but now the United States take the first place, followed by Soviet Russia, the United Kingdom and Germany. The high position of Britain was due largely to its early development, fostered by the easily accessible position of its deposits, the inventive skill of its people and the freedom of the country from external attack; these same conditions encouraged the early development of the manufacturing industries for which the coal was required. Other countries, however, have now been able to develop their industries and are beginning to utilize their coal resources. In all probability the United States, Soviet Russia, China, Canada and Germany have considerably greater deposits of coal, including lignite, than are to be obtained in the British Isles.

In addition to coal, natural gas and mineral oil are used as fuel for many purposes. For many years the United States produced and utilized these products, and in this century the use of oil has been greatly extended. In refining oil, the lighter kinds which are used for illuminating are separated from the heavier kinds used for lubricating and heating; the oils first used were those rich in the lighter kinds and oil did not largely supplement coal as a fuel. But recent improvements in constructing engines using oil have coincided with the discovery of great oil-fields yielding the heavier kinds, and consequently for locomotives, steamships and many industrial purposes coal has now an important competitor. The chief oil-fields are associated with the folded mountains which girdle the Pacific (in United States, Mexico, Venezuela, Colombia and the Dutch East Indies) and those which run from the Mediterranean to South-eastern Asia (in Rumania, the Caucasus, Iraq, Persia and Burma).

Metals.—Many rocks yield ores of such metals as iron, tin, copper and lead, which have economic importance. Among these the chief are the iron ores, which are widely distributed but are mined only where they are comparatively rich in the metal so that the yield repays the cost of extraction. Even in these cases, the facilities for smelting and transport may be lacking so that the important iron-mining regions are not so numerous as the distribution of the metal might suggest. In the production

of iron ore, as in that of coal, the predominance which formerly belonged to the United Kingdom has passed to the United States, for the ore production of Britain has not greatly changed for many years, and it is now exceeded by that of the United States and also by that of France and Soviet Russia.

Iron and steel are so greatly used for tools and machines that the ability to obtain iron easily is frequently a factor in the industrial prosperity of a region. In this respect iron differs from gold and other precious metals, which although valuable may not lead to industrial development in the region in which they are found. When gold is once extracted it is usually sent away to be made into money or used in other ways. The value of gold, however, induces miners to seek it under most unfavourable conditions, e.g. in the heat and drought of the Australian deserts or the cold and isolation of Siberia. Gold is like most minerals in being found in the older and harder rocks, but streams may have exposed and eroded the metal, re-depositing it in grains or nuggets among their sands. In several parts, as for example in Australia, such alluvial deposits have first been observed and worked and then traced to the original lodes where the work of extraction is more difficult although the quantity of metal may be much greater.

Building Materials.—The metamorphic rocks are themselves of value as providing durable building materials; hence marble, slate and granite are frequently quarried near centres of dense population or in coastal districts where transport by sea is easy. Sedimentary rocks, such as the harder limestones and sandstones, are used in the same way, clay is baked into bricks, and chalk and limestone are burned to obtain lime for mortar and cement.

MANUFACTURE

The term manufacture has extended its meaning from "making by hand" till it includes any work of adapting raw materials for man's use, irrespective of whether hand labour or machinery is employed. Manufacturing is now carried on chiefly with the aid of more or less elaborate appliances and on a comparatively large scale, and tends to be localized in places which are specially suited to the particular circumstances of each kind of

work. The localization of manufactures is controlled by many factors, among which three are of special importance, namely, facilities for obtaining the raw materials, for the provision of the means of carrying on the particular processes employed, and for the sale or distribution of the products.

The Supply of the Raw Material.—Although in many cases a considerable proportion of all the substances required in the industry consists of the raw material which has to be worked up into the finished product, yet it is not very common for manufactures to be carried on in the exact locality in which that raw material is produced. It may, however, be the case in such a simple industry as brick-making where the raw material is difficult to transport and other factors are relatively unimportant. Yet facilities for obtaining the raw material must always be considered, for heavy transport charges would be a constantly recurring expense if any industry were unfavourably situated in this respect.

Human Labour and Skill.—It is now very rare for an industry to be carried on solely by hand labour, but even where machines do much of the work the human labour is an important factor. For this reason works may be started in a neighbourhood where labour is easily obtained, and in industries requiring special skill this tends to prevent the introduction of those industries into new districts, except where it is possible to induce the workmen to migrate from other parts. For example, the long-acquired skill of the Lancashire operatives now gives Britain an advantage compared with other countries in which the cotton manufacture is in its infancy, and the experience of the steel-workers of Sheffield in making the finest kinds of cutlery militates against the competition of other localities.

Mechanical Power.—Much of the work is now done by machines driven by power derived from one of several sources. The first power thus used was that of swiftly-running or falling water, and before the end of the eighteenth century the woollen industry of Britain flourished in the Pennine valleys largely because of the water power there available.

At the end of the eighteenth, and throughout the nineteenth century, the use of steam power developed. The fuel mainly

used was coal, and because the transport of this was expensive, the manufactures requiring it were drawn towards the coalfields. Thus the use of steam engines aided the woollen manufacture already established in Yorkshire, at the expense of that carried on in the districts remote from coal. Although other factors have now assumed more importance than they formerly had, it is still true that the coalfields are the regions where manufacturing is most largely carried on, and consequently they are densely populated.

Towards the end of the nineteenth century, the application of electricity to industries became important. Electricity is not an additional source of power; it is a new means of making available already existing sources. By some power, such as falling water or an engine driven by coal, coal-gas, or oil, a machine called an electric dynamo produces an electric current. This current can be utilized in many ways: it serves to transmit messages by telegraph or telephone, it is used for lighting purposes, it is employed to extract metals from their ores, or it causes a wheel to revolve in an electric motor which can work any kind of machine. Since the current can be transmitted through a wire for many miles at a very small cost, the power from water or from coal is used to work a dynamo at the place where it is obtained; the current thus produced is cheaply distributed to surrounding points or transmitted to a distance, and so made to work machinery at places which may be far from the water or coal.

Consequently the application of electricity has had two important effects upon the distribution of industries: it has tended to disperse manufacturing from the immediate vicinity of the coal-mines, and to aid the establishment of works in regions well supplied with water-power which could not previously compete with steam for quickly-working machinery. Mountains well supplied with water and once glaciated regions where the rivers have numerous rapids are therefore tending to rival coalfields as industrial centres.

Auxiliary Materials.—Tools and engines are made almost entirely of iron and steel, and consequently there is some advantage to manufacturers in being within easy reach of iron; should an industry needing much machinery have to obtain this

from a great distance the transport would be costly although the expense would not often recur.

The smelting of metallic ores requires fuel whose provision is a very important factor, as most forms of fuel are so heavy and bulky. Charcoal was formerly the only fuel which could be employed for iron-smelting, and in those times the industry flourished where iron ore was found in the neighbourhood of forests, but during the eighteenth century the use of coal (or coke made from the coal) became common, and the iron-works were drawn to the coalfields. In the smelting of most forms of iron ore, the process is facilitated by the use of limestone which promotes fusion ; consequently the most suitable locality for the industry is where ore, coal and limestone are all available.

In a number of manufactures chemicals are required ; these may be obtained from various sources, among which deposits of common salt and potash salts are important. For example, the salt of Cheshire is utilized in the chemical works of South Lancashire, and some of the products are employed in the cotton industry of the same region.

A good supply of water, for some purposes pure and for other purposes with substances in solution, is a necessity in a number of processes ; thus paper-making is carried on in country districts where water is uncontaminated by town refuse ; the need of water to be used in dyeing and bleaching has affected the development of the textile industries in many parts, as the silk manufacture in the valleys of the Peak District ; the brewing at Burton-on-Trent is favoured by the water-supply from deep wells.

Atmospheric conditions may also play a part in some industries ; the dryness of the air at Budapest favours flour-milling, and the dampness of the air in Lancashire is of great advantage in cotton-spinning, for the threads tend to break in a dry atmosphere.

Marketing the Product.—After the raw material has been converted into the finished product, this has still to be distributed to the buyers, and that the distribution may be cheap and prompt is in some cases the reason for the localization of an industry. London has a great amount of manufacturing, particularly in the making of clothes and the preparation of food

for the millions of people in the Metropolis and its neighbourhood; consequently the cost of transporting the goods is very small and the makers are in close touch with the retailers, and so the facilities for marketing the produce (together with an abundant supply of labour) outweigh the disadvantage of being far from most of the materials required in the industries.

Similarly, the branch of the iron and steel industry which is concerned with the making of agricultural implements is drawn to agricultural centres, e.g. Norwich and Ipswich in the eastern counties of England. In this case, there is the additional advantage that the makers are at hand to repair the machines without delay. Another example from the iron and steel industry is the localization of shipbuilding at ports where not only are the materials iron, coal and wood easily obtained, but also re-fitting and repairs can be carried out when the ships return after a voyage.

Combined Facilities.—Where several materials have to be collected for combined use, as in the case of the coal, iron ore and limestone used in iron-smelting, the industry may be situated at any point which offers facilities for their collection, possibly at an intermediate point towards which convenient routes converge for the conveyance of the raw materials and the sending away of the products. The iron and steel industries of Cleveland and other towns on Lake Erie and Chicago on Lake Michigan have developed in consequence of such a convergence of routes.

Should a locality have several advantages for any particular industry it will attract many new enterprises of that character and so obtain a distinct pre-eminence; on the other hand a district with relatively few advantages may attract works for a time but these in the long run are likely to disappear, particularly at times of industrial depression when only the more favoured businesses survive.

Geographical Inertia.—Once an industry is established in a region, several considerations tend to retain it in that place. The labourers are there, arrangements for transport have been made, the business has become known; all these things are advantages which serve to help the industry against competition

which might arise elsewhere. Moreover, capital has been sunk in buildings and plant, and the organizers would do much to avoid the loss which would occur if the business failed. Hence industries may persist by a kind of " geographical inertia " even after conditions which favoured their establishment have passed away, and changes are usually slow.

Human Factors.—As in mining, so in manufacturing the human factors are of great significance. The supply of labour has already been referred to, but even more important is the possession of organizing ability and of capital. In considering why an industry is found in a particular locality, it is sometimes necessary to take into account even the energy and capability of an individual or a group of individuals, though in the course of one or two generations this may cease to be effective and the industry may disappear. Still more must one consider the human factors in explaining the development or non-development of industries in certain countries; for instance, the enterprise and initiative of the people of the United States must be contrasted with the conservatism of the people of China.

Political considerations need also to be taken into account; a tariff which hinders the import of certain articles encourages the manufacture of those particular articles in the country itself, and the same effect is sometimes produced by the remission of duties which would otherwise tend to prevent the export of the commodities, while in some cases, a direct bounty upon production is given in aid of desired industries.

COMMERCE

Commerce consists essentially of the exchange of the commodities which are most easily produced in one region for those most easily produced in another region. It may be divided into the work of the arrangement of the exchanges (e.g. the buying and selling of goods) known as trade, and the work of the actual conveyance of the goods known as transport; the two operations are very closely connected and occasionally carried on by the same persons.

Physical Factors affecting the Commerce of a Region.—As in

the case of other industries the development of commerce is controlled both by physical and by human factors.

Trading is likely to develop if the physical conditions of a region afford special facilities for special forms of production, so that it is economical to devote natural resources and human labour to a large production of particular commodities and then exchange at least part of these for other articles. Hence, if a region is suited to a few special forms of production it will have more commerce than if it could equally easily satisfy most of its own requirements.

Another great group of physical controls of commerce is connected with facilities for transporting the goods. Where these facilities are poor the transport will be costly, and so the advantages of the specialized production will be decreased.

It should be noted that as new methods of transport are discovered or old ones improved, a region may have its transport facilities greatly changed and its commerce may either increase or decrease in consequence. Thus the development of railways and ocean steamships made possible trade between the wheat-producing prairies of the new world and the markets of the old world; on the other hand the great size of modern ships has excluded them from some ports (e.g. Gloucester) which have thereby lost their importance.

It adds considerably to the expense of conveyance if full loads or cargoes can only be sent one way, either inwards or outwards, and endeavours are frequently made to adjust trade so as to avoid the return of empty trucks or vessels. Since Britain imports much bulky material, such as wheat, wool, cotton, timber and ores, but exports more valuable and more compact manufactured goods, the outward-going vessels will carry coal, which serves as ballast, at very low rates; this is a factor of great importance in promoting the British export of coal.

Human Factors affecting the Commerce of a Region.—The stage of civilization of a people has a great influence upon their capabilities in producing goods needed elsewhere, and so upon the commerce of their region. Moreover, their own wants, which tend to increase with advances in civilization, determine the nature and amount of the importation of goods.

The commerce may, however, be organized and carried on by people of other lands; this is now the case in many of the more backward parts of the world, as in the equatorial portions of America and Africa.

It is evident that commerce is closely bound up with the localization of other industries; thus on the one hand, where mining or manufacturing is the characteristic occupation of a district, commerce must exist in the form of an outward trade in the products of those industries, and an inward trade in other goods such as food-stuffs, while on the other hand it is only when and where commerce is possible that mining or manufacture can become the predominant industry.

Minor factors, dependent upon race and nationality, are differences of language, of money-standards, and of weights and measures; these differences are, however, usually capable of easy adjustment.

Political action may have great effect by the imposition of customs duties which have to be paid when certain goods enter or leave a country. These tend to reduce the trade in those goods, and so considerable increases or decreases in any particular branch of trade may result from the raising or lowering of these duties.

Commodities Imported.—A region imports those articles which are required, yet are either impossible or relatively difficult to produce in the region itself. Thus Britain imports tea because the climatic conditions will not permit its growth at all, and wheat because, except in certain parts, it is cheaper to devote land and labour to purposes other than the cultivation of wheat; were it not for the great facilities for mining and manufacture, a larger proportion of the people of Britain would obtain their living by wheat growing and other forms of agriculture.

In order to determine the imports of a region, it is necessary to consider both the requirements of the people for their own consumption, e.g. food, clothing and shelter, besides many comforts and luxuries, and also the materials they require for their industries, part of the products of which may be sent away, e.g. much of the raw cotton imported into Britain is exported later in the form of cotton goods.

Another point that has to be taken into consideration, is the difference between various commodities in regard to possibility of transport, for although certain articles may be somewhat difficult to obtain in any particular region yet they may be produced there if they are so heavy and bulky that conveyance would be costly, or if they suffer deterioration during transport, as in the case of fresh fruit and vegetables.

Commodities Exported.—From what has been stated, it will be seen that the exports of a region are those commodities which it is possible to produce easily and in greater quantities than are required for home consumption or use, provided that the transport is not too costly or otherwise too difficult.

Domestic and Foreign Trade.—The trade carried on within the boundaries of a country which is under one government and so forms a political unit, is termed domestic trade; that carried on between that country and other countries is termed foreign trade. Commercial statistics are usually to be obtained only with respect to the latter, although the domestic trade is nearly always the greater.

A political unit may include several more or less well-marked and differing natural regions which may be regarded as productive units. If these differ considerably there will tend to be much domestic trade between them, and if they together supply most of the needs of the people the foreign trade of that political unit may be very little notwithstanding great economic activity.

On the contrary, if the country comprises regions differing but little from one another, and has marked facilities for some special forms of production, then the domestic trade may be smaller and the foreign trade greater.

In estimating the importance to a country of its foreign trade, in addition to the foregoing considerations allowance should be made for the area and population of the country, so that for most purposes a better idea is obtained by taking the value of trade per head of the population than by taking the total value of the trade.

The Balance of Trade.—Since commerce is essentially an interchange of commodities, the total value of the imports into one country from all others must equal the total value of the

exports from that country to the rest of the world, after certain allowances have been made. That the value of the exports must balance that of the imports can be seen when it is realized that goods exported pay for those imported, and that money is only a medium to facilitate that exchange.

It is seldom that gold is sent from one country to another, and when that does take place it is largely because there has been an abnormal excess of either imports or exports and the money has had to be sent to redress the balance. But it is obvious that no country can continue to send out gold indefinitely, and on the other hand, to receive great quantities of gold would seriously affect the financial arrangements of the country to which it is sent. In actual fact the methods of payment are such that any abnormal excess of imports or exports tends to correct itself.

Yet in the case of some countries, and notably in the case of the U.S.A., the value of the imports normally exceeds that of the exports. This is chiefly due to the fact that the imports are sent not only in payment for exports, but also as interest on great loans made by Americans to those in other parts of the world, and in payment for other services rendered by people in U.S.A. to those in other countries. For example, a large proportion of the shipping of the world is owned in America, and a certain proportion of the banking and financial business of other countries is carried on in New York; payment for all this work is sent into U.S.A. in the form of goods, and by a circuitous process the proceeds of the sale of these goods are remitted to the shippers and bankers to whom the payments are due.

Methods of Transport by Land.—Many means of transport have been devised, and each of them is even now employed in some part of the world. Thus, human labour is the sole means of conveyance where physical conditions render other means difficult, for example, in the narrow paths of the dense equatorial forests and over very rugged country. Elsewhere, beasts of burden are used where they are specially adapted to the work; the sure-footed mule is utilized in many mountain regions; the camel, with a store of food in its hump and of water in its stomach, can travel across the desert for days without food or drink; reindeer and dogs draw the sledges over the snows of the

tundras. By none of these means can goods be carried in great amount or swiftly, and hence where they have to be employed commerce is confined to a few articles which can bear the expense and slowness of the transport.

Where roads can be constructed, carts are used; but except for the roads made by the Romans it is only recently that good ones have been constructed, and during the same period more efficient means of transport have been devised, so that the use of carts is chiefly confined to local traffic. The recent development of motor cars and motor lorries has led to a great increase in the use of roads for the conveyance both of passengers and goods.

Railroads have been the means of opening up many regions to commerce; their motive power is generally obtained from coal or oil, but recently electricity, generated at a central station and transmitted by a rail or wire, has been employed. Railways can deal with considerable quantities of goods at a time and transmit them more quickly than any other agency. The cost, too, is less than by other methods of transport by land. At the present day the development of great tracts of land is only awaiting the extension of railways to and across them.

Methods of Transport by Water.—Transport by water is on the whole much cheaper than by land, for the expense of making and repairing roads is unnecessary, and propulsion is easier through the water than on the land. Rivers therefore afford easy routes, lakes often add to the value of rivers, and with modern steamships the seas and oceans join rather than separate the lands.

Canals are usually constructed to render available or to supplement existing waterways; for example, they may connect two rivers or seas, rivers may be virtually turned into canals (i.e. canalized) by deepening and broadening, and waterfalls or rapids may be avoided by canals. Where changes of level are necessary, locks are constructed both in rivers and canals.

On rivers and canals boats may be propelled by hand or steam power, or towed from the bank; by such methods goods may be conveyed cheaply but usually slowly, and so only the heavier and bulkier goods are likely to be sent by these means; more valuable and perishable goods would go by railroad.

The power of the wind is utilized to some extent on inland

waters but mainly upon seas and oceans, and sailing ships were one of the chief means of transport for many centuries. But they have been superseded by steamships which have a greater speed, and are more likely to arrive to time because of their greater independence of the weather. Modern steamships can travel over 500 miles in 24 hours and carry a cargo equal in weight and bulk to several train-loads, at a cost per ton much lower than that charged by the railways.[1]

Ocean Trade Routes.—The routes by which traffic passes are determined by such considerations as directness, ease of transit, the avoidance of handling the goods where the means of transport has to be changed (an expensive matter), and the amount of traffic that can be obtained on the route to bear a share in the total cost.

Thus in ocean navigation, directness is obtained by following a "great circle" route (see p. 23), where this is possible.

A very great gain in directness was accomplished by the cutting of the Suez Canal, so that far more traffic goes by that route to the East than around the Cape of Good Hope. It should be noted, however, that only steamships can avail themselves of this route. A similar, though not so great advantage followed the opening of the Panama Canal in 1920.

Ease of transport is gained by taking advantage of winds and ocean currents; thus the ordinary route for sailing ships going from England to New Zealand was southward off the western shores of Europe and North Africa, across the Atlantic near the equator to get into the southward drift off Brazil, south-eastward in the latitude of the southern tropic and eastward in the belt of the westerlies south of Africa and Australia. On the return journey the westerlies would again be utilized, for the vessel would return around South America. (Refer to the maps showing winds and ocean currents.)

Handling is avoided by prolonging the ocean-voyage as far as possible; in many cases this may necessitate the deepening of a river, for example, the Clyde has been made navigable for great vessels as far as Glasgow, and in order that cotton and other goods may be taken directly to Manchester and avoid the

[1] For *Methods of Transport by Air* see Appendix.

transference at Liverpool, the Manchester Ship Canal has been constructed. The Kiel Canal joins the North Sea and Baltic.

To obtain more cargo the directness of a route is often sacrificed and ships put in at ports past which their voyage takes them; moreover, steamships need to replenish their coal and oil bunkers and so bunkering stations are established at convenient spots.

By far the greatest amount of trade follows the North Atlantic Route between the ports of north-western Europe (with Hamburg, London and Liverpool as the chief centres) and eastern North America, the chief gateway of which is New York. Second in importance to this route is that from north-western Europe through the Strait of Gibraltar and the Suez Canal; after reaching the Indian Ocean the traffic of this latter route diverges southward to East Africa, eastward to India, south-eastward to Australia and, after passing Singapore, north-eastward to China and Japan. The routes to the South Atlantic ports and those which round South Africa and South America have less traffic.

Inland Navigation Trade Routes.—Whether rivers can be used as trade routes depends upon several factors. One of the chief is their depth, and the deposition of silt or the blocking of their mouths by sand-bars is a serious difficulty which has frequently to be met by dredging.

Other rivers are blocked by ice during a portion of the year. The January isotherm of 0° C. approximately marks out the areas within which this usually occurs. Thus the rivers, the inland seas and canals of eastern Europe and eastern North America are extremely important for the greater part of the year because of the great economic activity of these regions and the fact that by these waterways the traffic may pass without hindrance for great distances, nevertheless they are virtually useless for many weeks in winter.

The difficulty presented by falls or rapids on rivers is overcome by the construction of canals or locks if the amount of traffic justifies the expenditure, but a more serious hindrance to the use of some rivers is the fact that they flow either to inland or Arctic seas and therefore do not form part of great natural

trade routes. Of this the most striking examples are the Volga system in Europe, the Ob, Yenesei and Lena systems in Asia, and the Mackenzie and Nelson systems in North America.

Land Trade Routes.—Relief is the chief control of the routes for land traffic. In regions of marked relief both roads and railways tend to follow the river valleys in crossing the higher ground, or to avoid the uplands by skirting the coast. In crossing a ridge, a pass is frequently found between the head of a valley on the one side and the head of a corresponding valley on the other, but if the pass lies at a great height or the gradients at the heads of the valleys are exceptionally steep, a tunnel may be made, perhaps several miles in length. As both haulage up slopes and tunnelling are costly, the rates charged on traffic across mountainous country are high. Thus although the Mount Cenis, Simplon, and St. Gotthard tunnels avoid the most difficult portions of the trans-Alpine routes, the much longer sea journey around Europe from the North Sea to the Mediterranean is the cheaper means of transit for heavy goods passing from Northern Germany to Italy.

It should also be observed that to avoid heights and steep gradients, long detours must sometimes be made and this adds to the expense; this expense, however, may be negatived if the lowland region traversed is productive and supplies local passengers and local freights. These share the cost of maintaining the roads or railways and so allow lower rates to be charged on the through-traffic.[1]

Trade Centres.—At certain points on trade routes, centres develop where buying and selling is carried on and goods are collected, distributed, or transferred from one means of conveyance to another. Frequently a considerable number of persons are concerned in work of this kind; others are attracted to the place because it affords facilities for carrying on other occupations, and so a great population may arise. The largest cities of the world are essentially trading centres at which other industries, such as manufacturing, printing and publishing, and the work of

[1] Many examples of the routes followed by railways are to be found in the sections on communications and commerce in the regional portions of this book. For air transport see pages 245 and 246.

administrators, lawyers, teachers and doctors, are conveniently carried on.

Among the points at which trade centres may develop are those at which routes converge, e.g. where important tributaries enter a great river, as St. Louis at the confluence of the Missouri and Mississippi, or where valley-ways meet (even if the streams themselves are not navigable), as Lyon where the upper Rhone valley joins the larger Saône-Rhone depression, or again where a land-route crosses a river at an important bridge-place, as Montreal where the north and south banks of the St. Lawrence are connected by railway.

Still more important, perhaps, are places which are at the end of a route on which a particular means of transport is employed, and where, consequently, goods have to be handled and may be distributed. Thus in suitable harbours at the end of ocean-navigation, the greatest ports of the world have grown up, including at the eastern end of the North Atlantic Route, London on the Thames estuary and Liverpool on the Mersey estuary, at both of which points the ocean traffic is connected with many roads, railways and canals leading to all parts of England, and Hamburg which lies between the ocean navigation and the inland navigation of the North German rivers and canals. At the western end of the same great route is New York, where the chief railways and waterways of North America open out upon the Atlantic.

As affording good harbours and thereby facilitating commerce and the growth of commercial cities, the indented "drowned" coasts may be compared with the unindented coasts resulting from uplift or fracture. Thus the eastern and western coasts of the United States are in sharp contrast, as are also the shores of Europe and Africa.

Smaller centres arise at the head of navigation of rivers where smaller vessels must load and unload, and also at points where, owing to considerable change in the direction of the river, traffic has to leave the stream, as for instance at Magdeburg on the Elbe.

Since the routes of railways (particularly in flat regions) are much less controlled by nature than those of waterways, a spot which attracts trade for any reason may have railways built to it, so becoming a railway centre, and once this has occurred

the place will grow for that very reason. In this way, St. Louis originally arose because of water transport, then railways were built to converge upon it, and now the traffic by river is not comparable with that by railway. Again, both London and Paris were placed at important bridge-points on navigable rivers and became centres of government; then the great railways of England and France respectively were built from them, and their further development in recent years is due to a considerable extent to their situation as railway centres.

Similarly, geographical inertia manifests itself clearly in the case of commercial cities, for although improvements or changes in methods of transport may put a city at a disadvantage, it may make efforts to obtain artificial facilities. Thus the Seine was deepened to allow the larger ships to go to Rouen after Havre had taken its place as the chief port of the Seine, and the Corporation of Bristol has built large docks at Avonmouth, a few miles below the old city.

Languages of Commerce.—English is the commercial language used throughout the British Colonies and Dependencies with the exception of South Africa, where the Taal (a form of Dutch) is also widely spoken. A corrupt form of the English language known as "pigin" English is in use in the ports of the Far East. Owing to the early conquests of the Spaniards and Portuguese, their languages predominate in the Republics of the New World south of the United States, Portuguese in Brazil, and Spanish elsewhere. Arabic, sometimes in a corrupt form, is the chief language of commerce throughout Africa north of the Equator and the Near East, while Chinese and Malay are very generally employed in the Far East.

AUTHORITIES AND BOOKS FOR FURTHER READING.

George Philip and T. S. Sheldrake: *Chambers of Commerce Atlas* (Philip).
E. G. R. Taylor: *Production and Trade* (Philip).
G. G. Chisholm: *Handbook of Commercial Geography* (Longmans).
J. Macfarlane: *Economic Geography* (Pitmans).
J. Brunhes: *La Géographie Humaine* (Paris: Alcan).
C. D. Forde: *Habitat, Economy and Society* (Methuen).
N. A. Bengtson and W. Van Royan: *Fundamentals of Economic Geography* (Prentice-Hall: New York).
C. F. Jones and G. C. Darkenwald: *Economic Geography* (Macmillan: New York).

CHAPTER XV

NATURAL REGIONS. DISTRIBUTION OF POPULATION

Natural Regions.—In dividing the world into Natural Regions it is necessary to consider only those outstanding differences of relief, climate and natural resources which have the most marked influence upon the development and activities of man. A region over which such physical conditions are uniform may be expected to form a productive unit, that is to say, to give rise to a certain group of associated industries, and two or more regions in different parts of the globe which repeat the same set of physical conditions may be expected to form productive units of a similar type.

For example, temperate grasslands, which are rather scantily watered, will probably be associated at first with pastoral industries, and these will give rise to such occupations as wool-cleaning and combing, leather-tanning, and the preparation of tinned meats, tallow, and bone-manure. These subsidiary industries will be carried on chiefly at some centrally situated town or port, and here an urban population will spring up; as a consequence there will be a demand for milk and vegetables, so that the additional industries of dairying and market-gardening will arise. Yet, as was explained in the last chapter, human factors such as the existence of a settled government, means of transport, and the possession of knowledge, experience, and skill by the workers have to be taken into account, and as these may not be uniform over a group of regions which are physically alike, the products may not be identical although they are similar.

In this general survey of the world only the larger divisions will be noticed, some of these being sub-divided in the later

chapters dealing with the separate continents. Regions which possess sufficient features in common to make it possible to group them under one type are indicated in the map (Fig. 112) by a single figure.

1^a . . . 1^d. These regions are uniformly hot and moist, and are clothed with dense equatorial forests, varied occasionally by richly-wooded grasslands. Among the forest products are rubber, cabinet woods (e.g. mahogany and ebony), gums, and valuable palms such as the sago, oil and coco-nut palms. The cultivated plants (plantation products) include manioc, rice, cacao, sugar, bananas, and in hilly regions, coffee. The climate of these regions is unsuited to Europeans, and they are therefore mainly inhabited by native races occupied in primitive agriculture, or merely hunting and collecting; since, however, tropical diseases can be largely stamped out, an increasingly systematic exploitation of these enormously productive areas by civilized peoples may be looked for.

2^a . . . 2^f. These are hot regions with a marked season of drought accompanied by a resting period in the vegetable world. The characteristic vegetation is savannah, but where, owing to local conditions such as relief, water is more abundant, there are considerable forests. In the latter areas the forest and plantation products are those of the regions of type 1; elsewhere, both stock-raising and agriculture can be carried on, although for the latter some irrigation is necessary. Among the crops are maize, millet, cotton and tropical fruits. Many of these regions suffer at irregular intervals from a failure of the rains, and the consequent destruction of stock and crops, but they are capable of great development, and the higher savannahs are suitable for European colonization.

3^a . . . 3^b. These are the great deserts, intensely hot and dry, and almost devoid of life except in the fertile oases. The effect of the isolation of Australia is seen in the contrast between the comparatively civilized pastoral, agricultural, and commercial peoples of the margins and oases of the Sahara and Arabia (the lands of the date and camel), and the primitive scattered peoples of the Australian desert who live by collecting roots and grubs, and hunting the rare game. The river oases

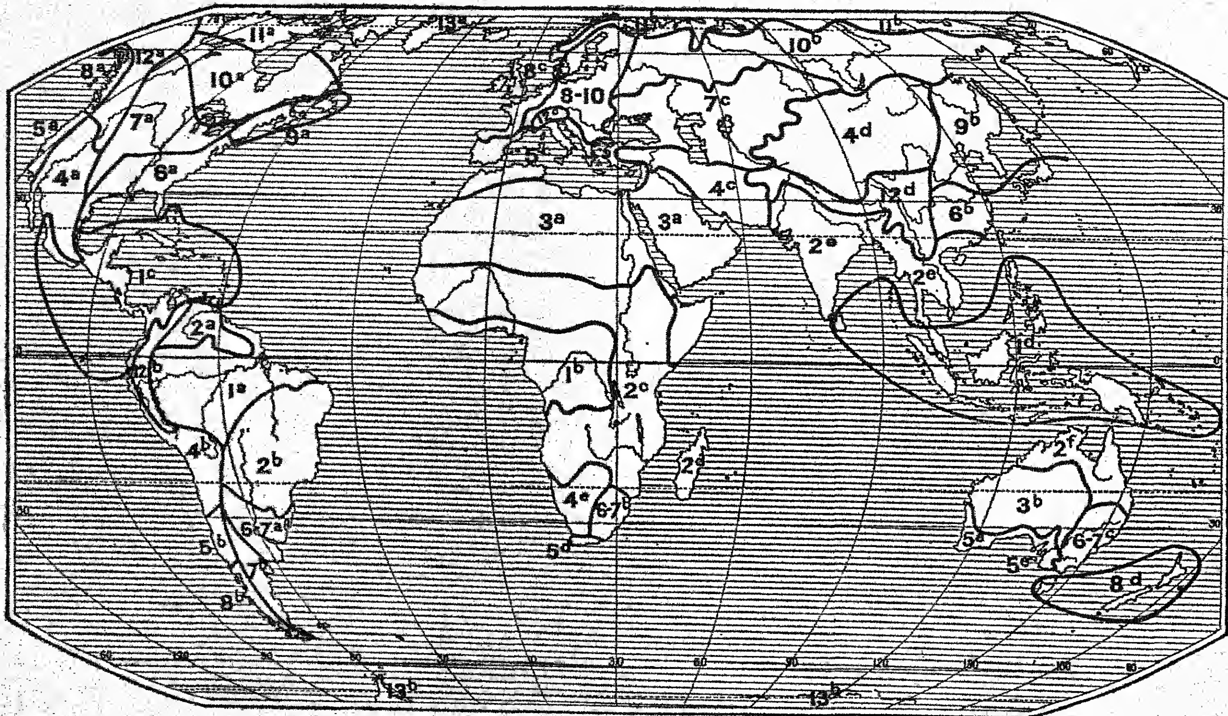


FIG. 112.—The Natural Regions of the World.

of the northern deserts, the Lower Nile and Mesopotamia, were the seats of the earliest known civilizations, the extraordinary productivity ensuring the existence of a wealthy and leisured class who could devote themselves to the arts and sciences.

4^a . . . 4^e. These are the arid tablelands, plateaus and basins found in different parts of the world where the heat and drought, though marked, are less severe than in the great deserts. They are for the most part covered with a sparse vegetation of scrub and are scantily inhabited by pastoral peoples (nomadic in Asia and Africa, but settled in the Americas, where they are largely of European descent), and by agricultural communities in those places where rivers or snow-fed mountain streams make cultivation possible.

5^a . . . 5^e. These are the warm temperate regions characterized by summer drought, i.e. having the Mediterranean type of climate and vegetation. All are occupied by Europeans or by peoples of European descent. They are agricultural regions and the characteristic products are wheat, wine, choice fruits, olives and silk, the dry summers often rendering irrigation necessary.

6^a . . . 6^b. These regions are found on the eastern margins of the northern continents and have a warm temperate climate; they have no real season of drought, and the hot moist summers ensure an abundant vegetation. They form very important agricultural regions, cotton, rice and sugar being produced in both, tobacco in America, tea and silk in China.

7^a . . . 7^c. These are great plains with a moderate and in parts a very scanty rainfall, occurring chiefly in summer; according to their rainfall they are clothed either with rich grasses or with poor grass and scrub. They are essentially stock-raising and pastoral regions, but in the better watered parts the natural grasses can be replaced by cereals such as wheat and barley, and in such areas agriculture becomes important.

$6{,}7^a$ . . . $6{,}7^c$. These three regions share the characteristics of the types 6 and 7. Climatically they are somewhat similar to 6^a and 6^b, but they are largely clothed with natural grasses and stock-raising is of equal importance with agriculture. In regions $6{,}7^b$ and $6{,}7^c$ the relief confines the more abundant rains to the coastal belts, so that in the drier interiors pastoral

industries, and especially sheep-rearing, predominate, whereas in region 6,7ᵃ, where the absence of coastal highlands allows a more uniform distribution of rainfall, the important cattle-rearing industry is being increasingly supplemented by the growth of cereals.

8^a . . . 8^d. These are the regions influenced by the warm moist westerly winds. Their natural vegetation is broad-leaved forest or well-grown coniferous forest, varied by natural meadows; wherever the forests have been cleared mixed farming is carried on, the agricultural industries including the cultivation of temperate cereals, root and fodder crops, and the pastoral industries including the rearing of sheep both for meat and wool, and of cattle both for meat and dairy produce. On the margins of these regions there are valuable fisheries.

9^a . . . 9^b. These regions, which lie on the eastern margins of the continents, differ from the last described chiefly as regards their colder winters and smaller rainfall. The occupations and industries are similar, except that the cattle must be fed and sheltered in winter, and that at this season water communications are interrupted. They, too, have valuable fisheries.

10^a . . . 10^b. These are the great northern coniferous forests; in their more remote parts fur-hunting is carried on, and in the more accessible areas lumbering is important. Their southern margins are being gradually cleared for mixed farming, for the summer days are long and warm and cereals ripen quickly, the hardier forms such as rye and oats being most important.

8, 10. This part of Europe forms as regards climate a transitional belt between the types 8 and 10, but the occupations are generally those of the region 8^c.

11^a . . . 11^b. These barren tundras are occupied by nomadic hunting and fishing peoples: in region 11^b the reindeer forms an important source of wealth, but the somewhat similar caribou found in region 11^a has not been domesticated.

12^a . . . 12^d. These are mountain regions (many have been omitted owing to the small scale of the map), where the varying altitude is accompanied by varying types of climate, vegetation and products. Pastoral occupations are important, the higher pastures being used in summer, the lower in winter; where the

valleys are warm and fertile, agriculture is carried on. The difficulties of communication and the consequent isolation of such regions have affected both the character of their inhabitants and the economic development of their resources.

13a . . . 13b. These are the cold deserts covered always with ice and snow, where no occupation other than fishing is possible, but the cold seas around them are rich in animal life.

Distribution of Population.—The distribution of population over the globe, as shown by the map (Fig. 113) is very complex, and cannot be explained simply by reference to physical conditions. For example, large tracts of the well-watered Amazonian forest are uninhabited equally with the rainless Sahara, and the thickly-populated plateau of Mexico contrasts with the thinly peopled yet very similar plateau of Bolivia. In very few instances can the present density of population be taken as an index of the natural productivity of a region, for a scanty population may be the result of difficulty of access, as in the case of the fertile eastern slopes of the Andes, or of legislative restrictions upon immigration, as in the case of Australia (see Chapter XXX), or of lack of skill and knowledge on the part of the inhabitants, as in the case of most regions inhabited by primitive peoples. On the other hand, the presence of valuable mineral deposits may over-ride natural disadvantages, as when gold draws many thousands into the desert of Australia or to the remote Lena valley. Then, too, there is a natural tendency among almost all peoples to cling to their native land, and hence in regions which have long been settled the population may become so dense as to cause widespread distress even though natural resources are made use of to the utmost, whereas in the "newer" lands, the Americas, Africa, and Australasia, vast resources lie almost untouched. Another factor to be taken into account is the tendency under modern industrial conditions for people to become massed together into cities, numbering hundreds of thousands, and in many cases even millions, of inhabitants.

Turning now to the map (Fig. 113) it may be noted that the most extensive areas of dense population lie in the monsoon regions of South-eastern Asia, where the simultaneous occurrence in summer of copious rains and great heat makes intensive

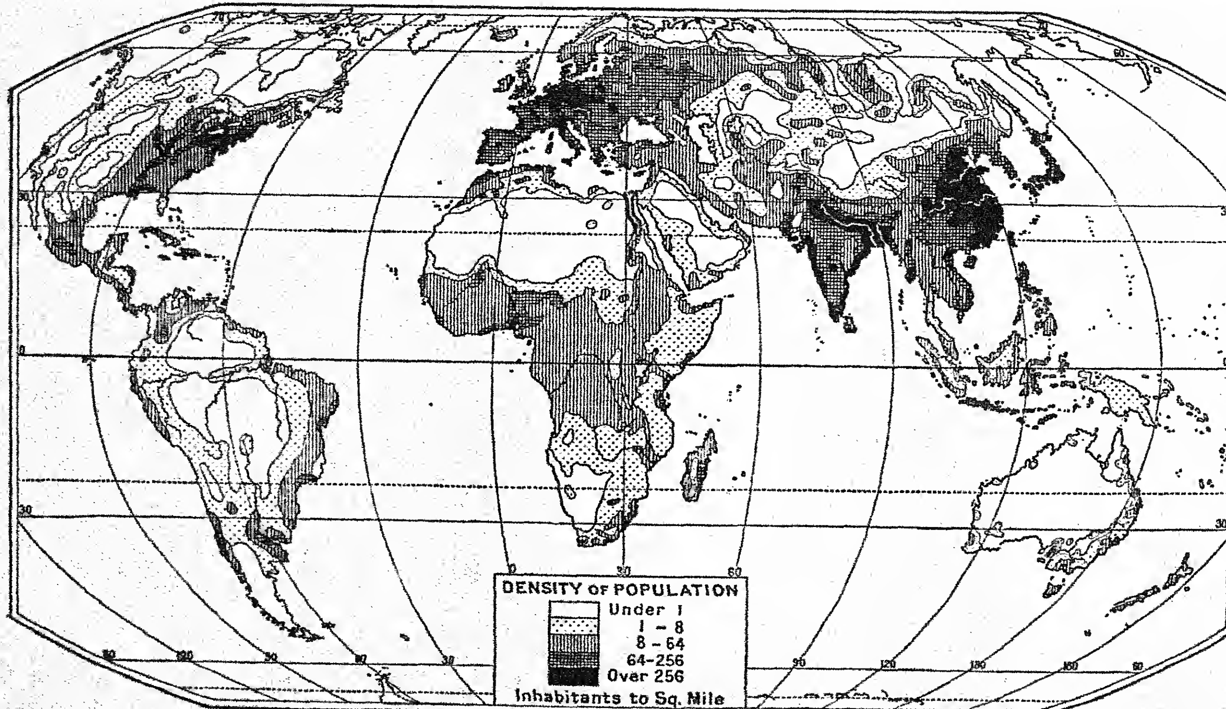


FIG 113.—Distribution of Population over the World.

agriculture possible. The Nile valley is a second densely peopled area, and shows the possibilities of an arid region; the insolation is very strong owing to the dry atmosphere, and as there is abundant river water for irrigation purposes, intensive agriculture can be carried on. The expenditure of capital upon irrigation works in India and the western United States has already had the effect of altering the distribution of population, and favourable estimates have been formed as to the future of irrigation in Mesopotamia, South Africa and Australia. A third area with a dense population is Java, which belongs to the type of region always hot and moist. With the exception of a small part of the Guinea coast no other region of this type is densely peopled, and it is evident that there is great room for development. The remainder of the densely peopled areas are all found in Europe and the United States of America, and include the great manufacturing and commercial centres which are characteristic of the western type of civilization.

The practically uninhabited parts of the world include such diverse regions as the great deserts of North Africa, Arabia and Australia, parts of the arid interior plains and basins of Asia and North America, the extensive coniferous forests and tundras of the north, together with the savannahs and forests of the monsoon region of Australia and a large proportion of the savannahs and equatorial forests of South America. The forests of the Amazon contrast with those of the Congo, for the latter are moderately well peopled, being almost everywhere dotted with clearings where the natives practise primitive agriculture.

It is important to notice that a comparatively well-peopled belt stretches across northern Eurasia from Russia to the Amur, occupying the southern margins of the coniferous forests and the neighbouring grasslands; in the corresponding belt across Canada the population is rapidly increasing. It may also be noticed that the Mediterranean region of southern Europe and North Africa is throughout well-peopled, and that in each of the four regions of a similar type found in the newer continents there is the nucleus of a considerable population. The three warm temperate eastern marginal regions of the southern hemisphere, the basin of the Plate river, south-east Africa and south-east Australia are also

well peopled as compared with neighbouring regions, although still scantily peopled as compared with the greater part of Europe. The fact that the Sudanese savannah can support such a dense population suggests that the same is true for other regions of the same type which are now only thinly peopled.

It appears, therefore, that the natural tendency of the population of the world to increase in numbers may, for a considerable time, be met by a utilization of large areas at present undeveloped, as well as by more scientific agriculture.

The immediate problem is not the insufficiency of the world's food-supply, but the adjustments of population that must take place, hastened in certain regions by emigration or immigration and by widely differing birth-rates. The relative importance of countries will be greatly affected, and this involves not only economic change, but also the increase or decline of the political power of the states concerned.

The greatest immigration movement has been to the United States, which received over 36 million aliens during the last hundred years. During the twentieth century, the population of the Argentine Republic doubled, largely by immigration, while the population of the Prairie Provinces of Canada (Alberta and Saskatchewan) rose from 90,000 to 1½ millions by immigration. Almost world-wide is the growth of urban at the expense of rural population, largely as a result of industrialisation.

APPENDIX.

Methods of Transport by Air.—The last twenty-five years have seen the rapid development of air transport. Of the two possible methods, namely by large dirigible balloons or air-ships, and by heavier-than-air machines (aeroplanes and hydroplanes), it is the last group that has proved most successful. A net-work of air-routes covers Europe and the United States, and there are long distance routes to the Far East and to the southern continents. The great speed and direct flight of the aeroplanes makes them very valuable for the carriage of mails and of urgent passenger and parcel traffic. They serve, too, to give access to

places which are difficult to reach by land, as for example places far from any railway in Brazil, Australia and Siberia. Seas, high mountains, dense forests, deserts, and even the polar regions, present no obstacle to air-transport, which is, however, relatively costly. It appears likely that it will soon be possible to reach any part of the earth in a very few days, and in that sense the size of the world is shrinking. Such developments are greatly facilitated by the rapid progress of radio telegraphy and radio direction-finding, which not only help to ensure safety of travel by air, sea and land, but bring the whole population of the globe into close verbal inter-communication.

The study of air-routes should be made with the help of a globe (preferably the new "rolling" type) rather than with an atlas, for Mercator's World Map, so useful to seamen, does not show at all easily the routes that should be followed by plane. The shortest way between, say, London and Melbourne, is of course, the great circle (p. 23) route, but since the aeroplane must take up and set down passengers at important intermediate towns, the actual line followed represents a compromise. For example, planes fly from London to Cairo, and on to Karachi, thence to one or more of the great cities of India, on to Rangoon and so by way of the Dutch East Indies to Port Darwin, and across Australia to Sydney and Melbourne. A new route is from London (Heath Row) by Lisbon to Bathurst (West Africa), across the Atlantic to Natal (Brazil) and thence to Rio de Janeiro and Buenos Aires. Another reason for deviating from a great circle is the desirability of re-fuelling stations at distances of a thousand miles or less. The weight of fuel needed for a long hop (say 3,000 miles) is so great that the "pay load" becomes very small. Oceanic islands take a new importance in an Air Age and the positions of Bermuda and Honolulu should be studied on the globe. The reason why Pan-American Airways lead in the Pacific Ocean is fairly obvious when one studies the political affiliations of the North Pacific islands.

AUTHORITIES AND BOOKS FOR FURTHER READING.

Geographical Association: *Report of Committee on Classifications of Regions of the World* ("Geography," Dec., 1937).
M. Epstein: *The Statesman's Year-Book*. [For up-to-date statistics of many kinds.] (Macmillan.)
A. M. Carr-Saunders: *World Population* (Oxford Press).
W. D. Forsyth: *The Myth of Open Spaces*.

Part II
REGIONAL GEOGRAPHY

[*Note to Students.*—In the study of each of the regions treated in the following chapters, reference should be made to the sections in Part I where the broader features of the regions are dealt with. Similarly, the maps in Part I should be frequently consulted.

A number of facts are given in Part II without explanation, it being assumed that the student will supply an explanation based on the general principles given in Part I.

Maps adequately showing the relief of the land as well as political divisions must be constantly used in connexion with these chapters. The atlas is indispensable; the positions of places named in the text should always be verified and their relations examined with the aid of the map. The making of simple sketch-maps showing particular facts is recommended. Only by constant map-work can the situation and relations of places and the physical and economic conditions of regions be realized and remembered.]

CHAPTER XVI

THE BRITISH ISLES

POSITION AND EXTENT

Form and Area.—An examination of a map shows that the British Isles are an archipelago consisting of two large islands and many smaller ones, occupying a triangular area off the north-west coast of the continent of Europe.

Three points mark the extremities of this triangular area, namely, Dover in the south-east, Valentia Island in the south-west, and the north of the Orkney Islands in the north. If these points are joined by straight lines it will be found that the distance from Dover to Valentia is 500 miles, from Dover to the Orkneys nearly 600 miles, and from Valentia Island to the Orkneys nearly 600 miles.

The area of the islands is about 121,000 square miles, of which Great Britain occupies 88,000 and Ireland nearly 33,000 square miles.[1]

World Position.—Since the British Isles lie between the fiftieth and sixtieth parallels of latitude they are nearly two-thirds of the distance from the equator to the poles. The effect of this situation upon climatic conditions will be more carefully considered later; for the present it is sufficient to notice that the climate is such as to reward labour with an adequate food supply, but the temperature is not high enough either to produce an abundance of food without labour or to enervate the population.

Viewed upon a globe, the British Isles are seen to lie near the centre of the land hemisphere, i.e. that half of the globe

[1] The statistics given in *this* paragraph may be committed to memory, as a standard with which to compare the distances and areas of other regions.

which contains all the lands except Australasia and the south-west of South America. Therefore, as in early times Britain was in touch with civilized Europe, so in recent years it is well placed for communication with the other continents. Further, since ocean transport is so important for commerce, its situation on the Atlantic margin is an additional advantage.

The Surrounding Seas.—The British Islands are really the higher parts of the partially submerged north-western portion of Europe. The true edge of Europe is marked by the position of the line showing a depth of 100 fathoms. This line encloses the North Sea, the whole of the British Isles and the northern part of the Bay of Biscay. Within this line is the continental shelf, the lower parts now lying just below sea-level and covered by the shallow seas surrounding Britain, the higher parts standing above the water and forming these islands.

Between Britain and the continent the seas are narrow, the Strait of Dover being only 21 miles wide. Hence peoples and ideas have migrated westward from the continent, the narrow seas opposing no serious barrier to peaceful movement. Yet the same seas have aided the peoples of these islands to maintain their independence, for there has been no successful invasion since the defence of Britain has been organized throughout the region.

Much of the continental shelf is near the surface, and the greater part of the North and Irish Seas and the English Channel have a depth of less than 50 fathoms, while the Dogger Bank in the centre of the North Sea lies between 10 and 20 fathoms. This shallowness allows of the great fisheries, from which fish worth more than twenty million pounds are annually obtained.

Tides.—Another result of the shallowness of the seas is the height of the tides, which though but a foot or two in the open ocean, is as much as sixteen feet at the Scilly Isles. Obstructed by the land the tidal wave splits into three portions, one following the Atlantic border, while the others penetrate the St. George's and English Channels. Along the former course the wave moves more rapidly than in the Channels, so that high tide is brought to the northern entrance of the North Sea at the same time that it reaches Liverpool and the Strait of Dover. The northern wave

proceeds southward through the North Sea, reaching the mouth of the Thames in about twelve hours, i.e. when another wave has reached this region through the English Channel. The two waves coalesce, thus giving exceptionally high tides in the Thames estuary.

The rise and fall in shallow waters necessitates the alternate drawing in and sending out of water, so that alternating tidal currents are formed. In the estuaries they are utilized to move shipping in and out, and they also help in clearing the passages of silt. Thus at London, which is 60 miles from the sea by the river's course, the spring tide has a rise of 21 feet. Hence the port owes much to the tides and tidal currents, for without them the great vessels could not ascend nearly as far up the river, the boats and barges would require much more motive power, and the dredging would be far more expensive.

CLIMATE

Wind Systems.—Situated on the western margin of a continent between latitudes 50° and 60° N., the British Isles are in the region of the westerlies throughout the year. An examination of Figs. 71 and 72 shows that these islands are largely under the influence of the great Atlantic pressure-systems. In January, the dominant system in the North Atlantic is the "Low" in the neighbourhood of Iceland with a counter-clockwise air-swirl producing south-west winds over Britain. In July, the Azorean "High" has developed, with a clockwise air-swirl giving more westerly winds to these islands. This is shown by the wind charts in Fig. 114, from which it appears that both in January and July about 21 per cent. of the observations in England exhibit the wind as coming from the south-west; in January 17 per cent. of the winds come from the west, while in July this proportion is raised to over 20 per cent.

Britain is also under the influence of travelling cyclones; on an average, one cyclone reaches these islands every ten days, but their occurrence is more frequent in the winter months as they are generally associated with large areas of low pressure, such as that over the North Atlantic in winter. The passage of a cyclone over a place causes winds to blow from varying directions

(see Fig. 75), and the wind-charts show the influence of the winter cyclones, for in January over 24 per cent. of the wind-directions are between S.E. and N.E., whereas the corresponding proportion for July is only 16 per cent.

The cyclones usually travel in an easterly direction across Britain and frequently, though by no means invariably, travel along certain tracks. The most noticeable of these tracks is that

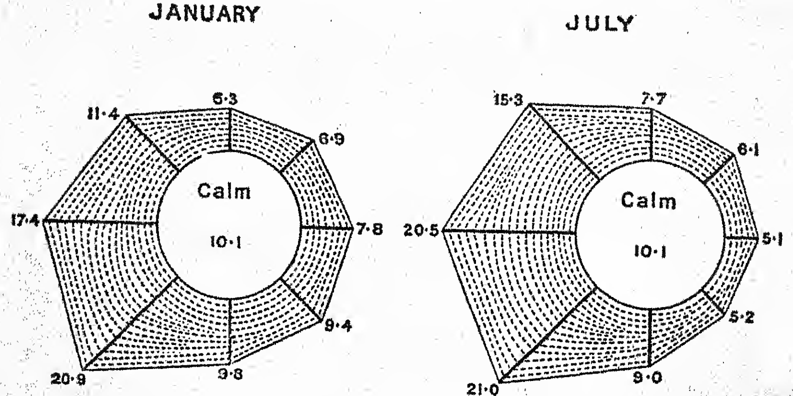


FIG. 114.—Mean Frequency of Wind Directions and Calms in England.
(The numbers denote percentages of the total observations.)

above the edge of the continental platform, from the south-west of Britain past the Outer Hebrides and the mouth of the North Sea. Hence the western and northern portions of the British Isles are very considerably affected by cyclones; moreover, this influence is most marked in winter, for this track is then more frequented than in summer.

Anticyclones occur less frequently but are more enduring, for in Britain they do not usually travel but develop by the gradual spreading of high pressure from some centre. In summer they may extend over the south of Britain from the Azorean "High," and in winter they may extend over the east of the islands from the Eurasian "High." The wind-charts show that, taking England as a whole, the calms associated with anticyclonic conditions are equally common in January and July.

Temperature.—The mean temperature conditions in July,

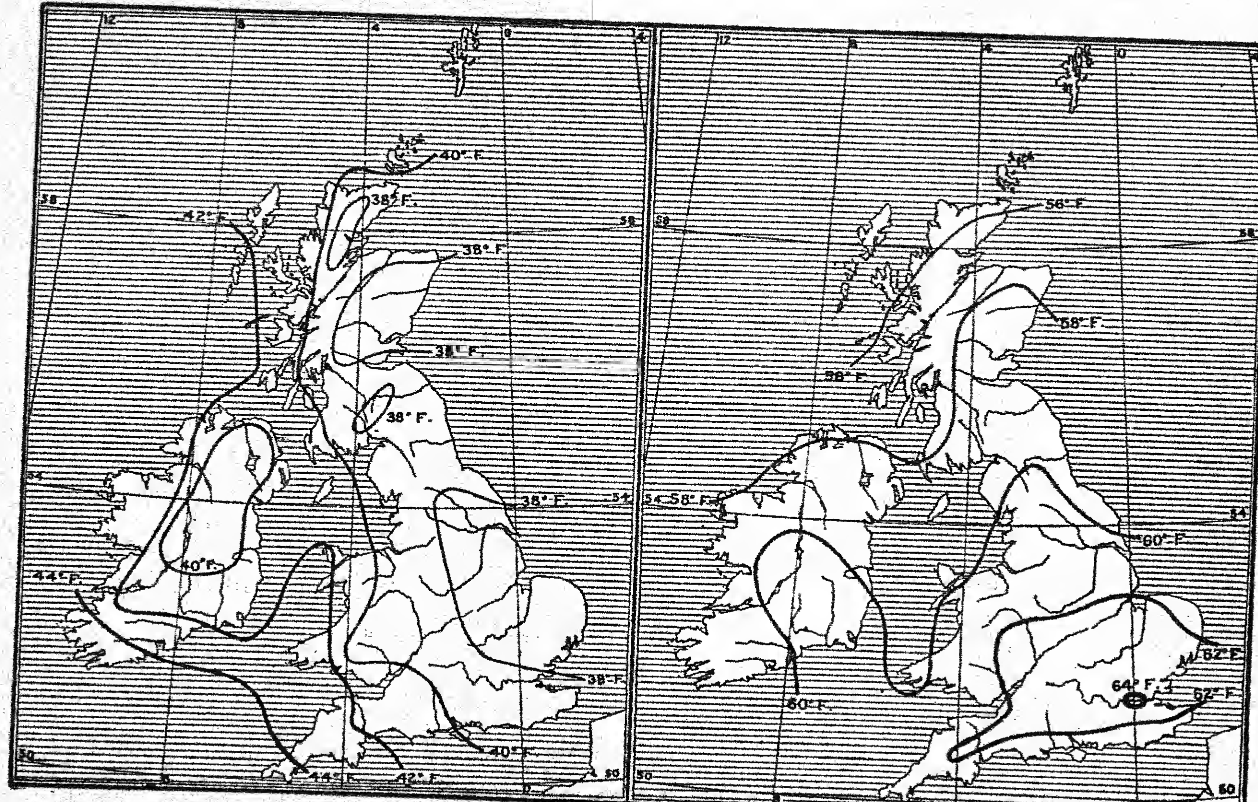


FIG. 115.—Mean Sea-level Temperatures, January and July.

allowance having been made for elevation, are shown in Fig. 115. The hottest part is in the south-east, where there is a large area with a temperature over 62° F. (16·7° C.) and a very small area over 64° F. (17·8° C.). This relatively high temperature of the south-east is due partly to the Sun's rays being more oblique in the north, and also to the cooling influence of the sea being more effective in the west. The bending of the isotherm of 60° F. (15·6° C.) northward over the lands and southward over the Irish Sea also shows the same cooling influence of the water. A straight line drawn through Anglesey in a north-east and south-west direction would give the general trend of this isotherm, and the same general direction is followed by those of 58° and 56° F. (14·4° and 13·3° C.) farther to the north-east.

In January (see also Fig. 115) the coldest regions, those below 38° F. (3·3° C.), are in the east. The map shows little difference as between north and south, thus indicating that at this season the angle at which the Sun's rays are received has less influence upon the temperature, and that the chief factor is the warming influence of the sea which, through the agency of the westerly winds, raises the temperature of the west above that of the east. The trend of the isotherm of 40° F. (4·4° C.) from Cape Wrath to the Isle of Wight is on the whole from north to south, and its deviations from this direction emphasize the effect of maritime influences. In the north-east of Ireland, where the south-west wind has least effect, there is a large area with a mean temperature below 40° F. Similar facts are to be observed in regard to the courses of the isotherms of 42° and 44° F. (5·6° and 6·7° C.).

A comparison of the maps shows that the greatest annual range is experienced in the south-east where a large area has over 62° F. in July and under 38° F. in January, thus having a range of over 24° F. (13·3° C.), and that while in no part of the British Isles is there an extreme climate, the most equable region is in the west.

These maps and the statements deduced from them deal only with sea-level temperatures, and the fact that the highlands are largely in the north and west makes it necessary to consider the actual temperatures without the reduction to sea-level, in order

to obtain a true idea of the climatic conditions. This is specially necessary in regard to the summer conditions, when the actual

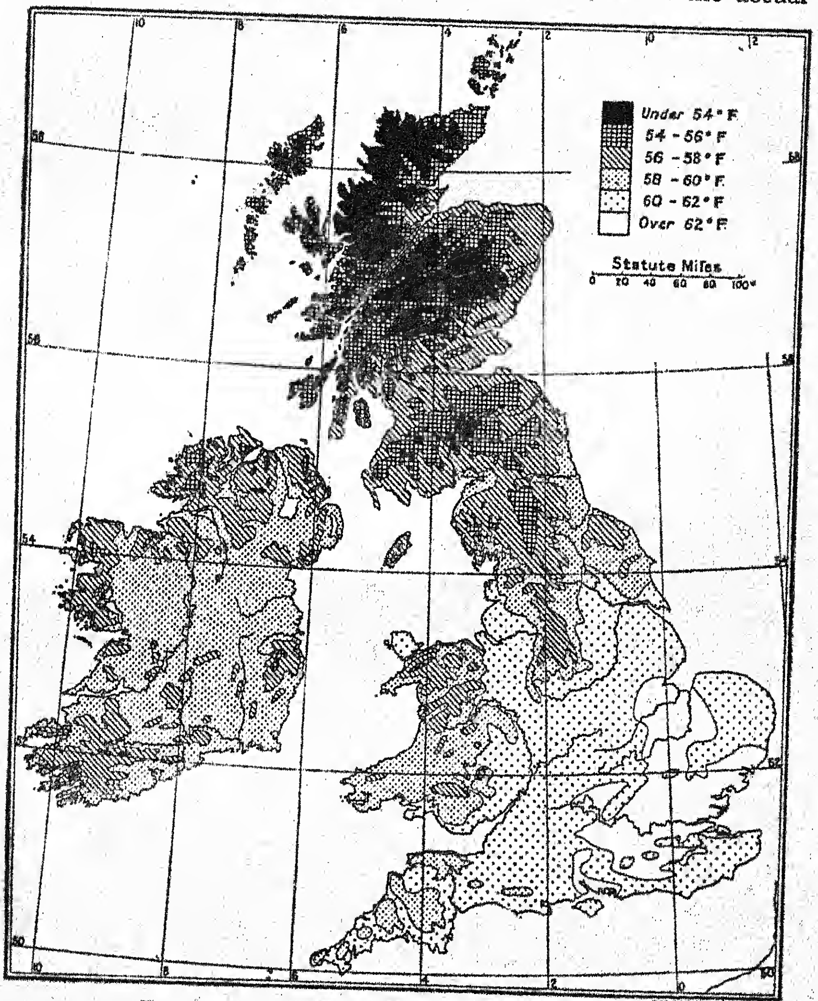


FIG. 116.—Mean Actual Temperatures during July.
(*Not reduced to sea-level.*)

temperatures experienced determine the growth of vegetation. Fig. 116 shows the mean actual temperatures for July. The

contrast already observed between the south-east and north-west is here seen to be intensified over very large areas, and the effect of this difference on possibilities of plant growth must be borne in mind.

Rainfall.—The map in Fig. 117 shows that there is a heavy rainfall over the western portions of both islands, and the heaviest rain occurs where the higher lands adjoin the western coasts. Even on the east of the higher lands and over the lowland areas adjoining the eastern coast there is no lack of rain, for only very small areas receive much less than 25 inches a year.

The explanation of the heavier rainfall of the west is to be found partly in the direction of the prevailing winds and partly in the relative frequency of cyclones. The rains of the eastern lowlands are of the cyclonic type.

The rainfall is well distributed through the year but the maximum occurs in the autumn and winter seasons.

VEGETATION

The climatic conditions are those which would in a natural state favour the existence of broad-leaved forest, and there is no doubt that very long ago the British Isles were very densely wooded, though these forests have now disappeared. The table on p. 259 shows that in Great Britain only about 5 per cent. of the land is now covered with trees, and but 2 per cent. in Ireland.

The existing woodland does not generally represent the remains of the original forest; it consists of more or less recent plantations. No doubt a considerable proportion of the land could still bear forest, and in several parts land which until quite lately has been comparatively barren and useless has now been planted with trees. This afforestation will doubtless be extended and will add to the resources of these islands. A quarter of the total amount of woodland is in Scotland, where it mainly occupies the valleys and the eastern borders of the Highlands, and one-half of it is in England, where it is often found on hills with a rather poor soil.

A far larger area is moorland, bearing little save heather, bracken, moss and some poor grass. In England and in Wales, much of the land over 1,000 feet, and some below it, is of this

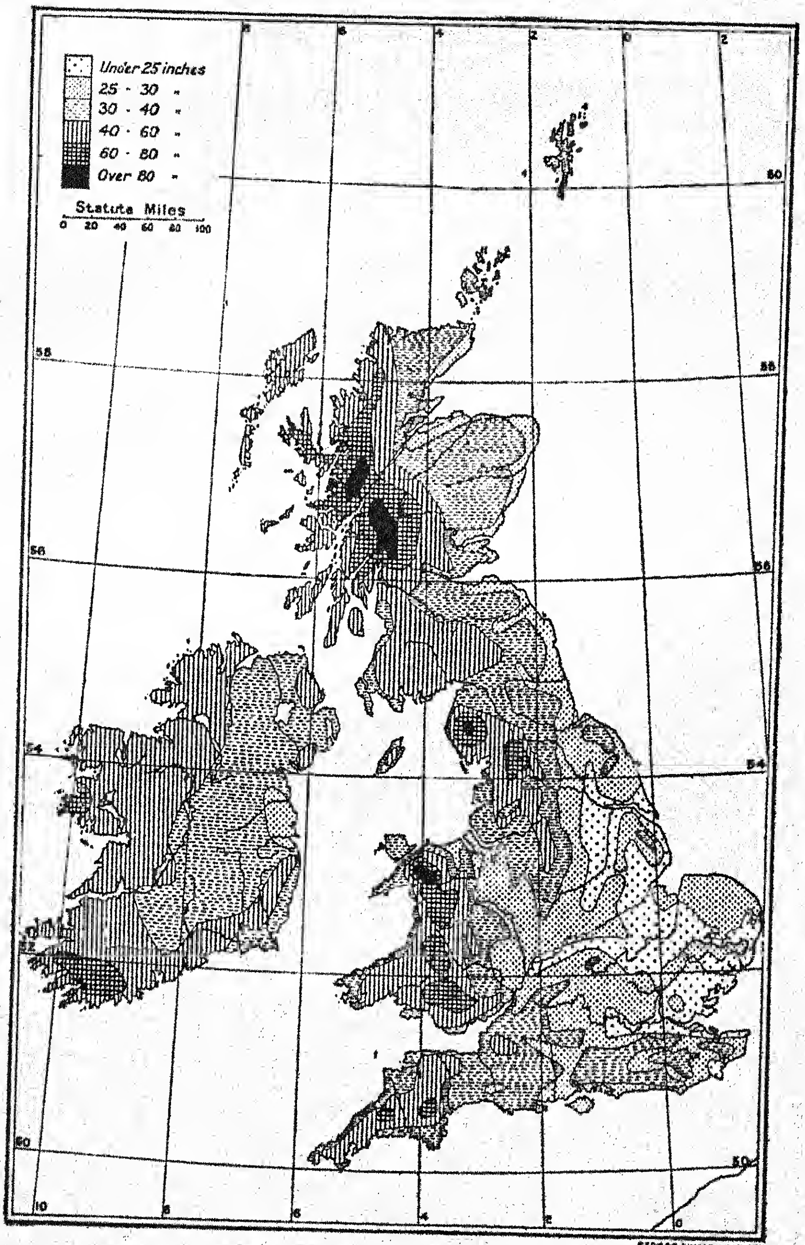


FIG. 117.—Mean Annual Rainfall. (After Mill.)

character; over a great part of Scotland and Ireland the land over 600 feet is mainly moorland, and in the extreme west of Ireland and the north-west of Scotland this kind of ground extends down to sea-level. Such land forms poor grazing-land, classified in the agricultural statistics as "Mountain and Heath"; it can be but scantily used and above it is bare rocky ground absolutely worthless.

The remaining portion of the land is nearly all utilized either for permanent pasture, or for crops of various kinds. Since the natural vegetation has been so largely displaced, the present agricultural conditions, although strictly an economic matter, may be introduced here to indicate the differences which climatic and other physical factors still cause in the vegetation of the various parts of these islands. The accompanying table shows the chief uses to which the land is put, and the relative importance of these in the four parts of the United Kingdom. It is constructed by taking the averages of the figures for several years at the beginning of the twentieth century.

Attention has already been drawn to the small proportion of woodland. The next lines show what a large proportion, namely 54 per cent., of the country is devoted to grazing, chiefly of cattle and sheep. In England the percentage is rather less, and the land is on the whole of a better quality, for only 7 per cent. is returned as of the poor "mountain and heath" type, while 41 per cent. is of the better "permanent pasture" type. These proportions are almost reversed in Scotland, where so much of the land is upland of little value. The difference is reflected in the statistics showing the number of animals per thousand acres, for Scotland has fewer sheep and less than half as many cattle in proportion to its size, notwithstanding the large percentage of grazing land. The statistics relating to Ireland do not distinguish between the poorer and the better types of grass-land, but the very large number of cattle, 222 to the thousand acres, suggests that the latter is relatively abundant. Wales has the largest proportion of grazing land, and this seems to be well used, for Wales has many more sheep in proportion to its size than any other part of the United Kingdom, and in regard to cattle ranks second only to Ireland. It must be

AGRICULTURAL STATISTICS OF THE BRITISH ISLES.[1]
Percentages (*to nearest integer*) of Total Land Area.

	England.	Wales.	Scotland.	Ireland.	British Isles.
Woods and Orchards . . .	6	4	5	2	4
Mountain and Heath . . .	7	24	49	?	?
Permanent Pasture . . .	41	41	7	?	?
Total for Grazing	48	65	56	57	54
Potatoes	1	0	1	3	2
Root Crops	5	1	3	2	3
Rotation Grasses, etc. . . .	11	9	8	7	9
Total for Green Crops . . .	17	11	12	12	14
Wheat	6	1	0	0	3
Barley	5	2	1	1	3
Oats	6	5	5	6	5
Rye, etc.	1	0	0	0	1
Total for Corn Crops . . .	18	8	7	7	11
Non-Agricultural	11	12	20	24	17
Animals.	Number per 1,000 acres.				
Cattle	144	150	65	222	146
Sheep	490	696	397	212	407

remembered that in respect of absolute numbers, the greater size of England gives it the first place both for cattle and sheep rearing; for example, England has nearly sixteen million sheep and five million cattle, whereas Wales has only about three million sheep and one million cattle.

Among the figures relating to green crops the relatively large area given to potatoes in Ireland is worthy of notice. The bulk of these green crops is grown as food for animals, the chief roots being turnips, swedes and mangolds.

[1] The figures in this table should not be committed to memory. The table is given because it states accurately and concisely some important facts which may be extracted, as is done in the paragraphs accompanying the table, and then learnt by connecting them with their causes or with some other known facts.

It is in the corn crops that the greatest contrast between the east and the west is to be observed, England giving by far the most attention to this kind of cultivation. The difference is most striking in the case of wheat, for while England has 6 per cent. of its area under wheat, Wales has only 1 per cent., and in both Scotland and Ireland the area is less than one-half per cent., this little being grown almost entirely in the eastern parts of these countries. The reason for this distribution lies of course in the relative dryness of the south-east of Britain combined with the greater heat and sunshine during the ripening season. The contrast is still seen, though it is less marked, in the case of barley. The difference between the two crops is connected with soil rather than climate; wheat is usually grown on the more clayey soils, while barley is grown on the more sandy and frequently somewhat poorer ground. In the case of oats the contrast between east and west disappears entirely; this crop is adapted to withstand greater moisture and so there is practically no difference in the extent to which it is cultivated in the four divisions.

Land classed as non-agricultural may be used for other purposes, e.g. for buildings or roads, or it may be quite valueless, as are some of the higher areas in Scotland or the morass-like parts of the bogs in Ireland.

THE PEOPLE OF BRITAIN

The east of Britain is inhabited by people who are mainly long-skulled, tall and fair; they are therefore included among the Northern European race, as was shown in Chapter XII. The people of the west are equally long-skulled, but on the average are considerably darker and shorter; this indicates that they belong to the Mediterranean race.

History confirms the conclusion that the people of the eastern part are of the Northern European race, for they are known to have come from the coasts of the North Sea and Scandinavia; they were Teutonic tribes, including the Jutes, Angles and Saxons, who arrived first in the fifth century A.D., and the Danes and Scandinavians who came later. The people who are now in the west then inhabited the east also, but numbers were

destroyed, others enslaved and absorbed by the Teutons, while many retreated gradually westward. This evidence suggests that people of the Mediterranean race first inhabited Britain and that they were partially displaced by Northern immigrants, but a difficulty is presented by the fact that the languages of the people of the west belong to the Keltic group, i.e. the languages originally spoken by the "Alpine" peoples of central Europe. The explanation is that before the Northern invaders came, some of the Alpine peoples reached Britain, found here inhabitants of Mediterranean race, conquered them and forced them to speak their Keltic tongue, but did not exterminate or displace them. This explanation is borne out by the fact that round skulls, characteristic of the Alpine peoples, are found in burial barrows dating back to the centuries just before the Christian era; in all probability the round-skulled Alpine people gradually died out, although their languages survived.

The Keltic languages of western Britain fall into two groups: in the first are the Gaelic of the Scottish Highlands, the Erse of Ireland and the Manx of the Isle of Man; in the second group the Cymric of Wales is the sole survivor at the present day, but the old Cornish language was very similar to it. The two groups have certain differences, e.g. the Gaelic group has K or Q as in Kin=Head (Kintyre and Kinsale) where the Cymric group has P (Penrhyn). The differences are due to the fact that the two groups of languages are derived from two branches of the Alpine peoples, the first comers speaking the dialects which employ the Q sound and the later ones using the P sound. The "Q-Kelts" migrated or were driven to the remoter parts of Britain, while the "P-Kelts" maintained themselves in the Welsh and Cornish peninsulas. The Keltic tongues seem to be dying out in Britain, being gradually replaced by English, derived from the Teutonic Angles.

The chief immigrants into Britain seem, therefore, to have been: (1) peoples of the Mediterranean race who came before historical times; (2) Alpine peoples, the "Q-Kelts" and "P-Kelts" who came some centuries B.C., imposed their speech upon the inhabitants but themselves died out in the course of time; (3) the Romans, who conquered and left cities and roads,

but did not affect the racial characteristics of the people ; (4) the Teutons and Northmen, who drove the previous inhabitants to the west of the islands and later gradually extended their language over the larger part of Britain ; (5) the Normans, who modified the government and language but did not come in sufficient numbers to influence the race appreciably.

The peoples of Britain are now united under one Sovereign, and London is the seat of the government of Great Britain and Northern Ireland. In 1921 the Irish Free State, now known as Eire, was formed for the government of 26 counties of southern Ireland, with its capital at Dublin. Where British people have settled abroad, in Canada, Newfoundland, South Africa, Australia and New Zealand, colonies have been formed. These have "Dominion status," i.e. they have independent governments for home affairs, but they own allegiance to the Sovereign as the head of the British Commonwealth of Nations, as members of which they consult in matters of foreign affairs and defence.

The great increase in the number and power of the people of Britain has taken place within the last 150 years, and has been due to the development of manufactures and commerce ; it has, however, to some extent been counteracted by a decline in agriculture and a decrease in the agricultural population, owing to the opening up of the fertile lands of the new world. In England and in South Wales the decline in the rural districts has been much more than balanced by the growth in the urban districts ; over the central lowlands of Scotland the same is the case, but in almost all parts of Ireland, where coal and iron are lacking, the agricultural decline has caused a great decrease in the total population.

Of the 49,000,000 people in the United Kingdom, England and Wales together have about 40,000,000, Scotland has nearly 5,000,000, and Ireland rather more than 4,000,000. The comparative natural resources of these regions are indicated by the fact that whereas England and Wales have, on an average, about 700 people to the square mile, Scotland has 160 and Ireland less than 140 people to the square mile.

For authorities and books for further reading, see end of Chapter XIX.

CHAPTER XVII

THE BRITISH ISLES—*Continued*

SURFACE FEATURES, STRUCTURE AND MINERALS

Outlines of Relief and Structure.—No part of the British Isles has mountains comparable with those of the mainland of Europe, and there are few considerable areas above 2,000 feet in elevation. The greatest of such areas are those in the north-west of Scotland. A line drawn from the mouth of the Clyde to Stonehaven cuts off the region known as the Highlands. Between this line and one drawn parallel to it from Girvan to Dunbar lies the Central Valley of Scotland, and south-east of the latter line are the Southern Uplands. The Highlands and Southern Uplands represent great blocks of hard and ancient rock between which the Central Valley has been let down by parallel faults along the lines indicated.[1]

Scotland is separated from the larger part of Great Britain by the Cheviot Hills, a mass of old igneous rocks. South of this there are three upland areas: the Pennine Chain is an upfold of rocks of Carboniferous age (marked as Coal-Measures, Millstone Grit and Mountain Limestone on the map in Fig. 118), while the Cumbrian or Lake District and the Cambrian or Welsh Uplands are formed of masses of older rock in many ways similar to that of the Southern Uplands. The south-western peninsula of Devon and Cornwall is also formed of old rock but bears only a few upland districts. The south-east of Britain is lowland, diversified by ridges of no great elevation, and is composed of younger rocks. The Isle of Man is closely comparable with the Lake District in structure.

[1] This text should be constantly compared with the orographical map in the atlas and the geological map in Fig. 118, and the connexion between the two maps should be carefully noted.

Ireland has scattered upland masses which largely correspond with those of Great Britain. In structure and appearance the mountains of Donegal and Connaught resemble those of the Scottish Highlands, from which they have been separated by the erosion and subsidence of the intervening masses; the Mourne Mountains and the Slieve Bloom Mountains prolong the line of the Southern Uplands; the Wicklow Mountains correspond with the Uplands of North Wales, while the ridges in Munster are a continuation of the mountains of South Wales. The plateau of Antrim has been built up by outpourings of lava. Most of the remaining portions of the country are lowland and composed of limestone of carboniferous age.

The Scottish Highlands.—The north of Scotland may be divided into five parts: the Outer Hebrides, the Inner Hebrides, the Northern Highlands north-west of Glenmore, the Grampian Highlands south-east of Glenmore, and the north-eastern coastal plains with the Orkney Islands.

The Outer Hebrides are the worn-down fragments of some of the oldest land on the Earth's surface, mostly lowland yet not fertile. Very similar are the Shetlands, set like stepping-stones between the British Isles and Norway. Some of the Inner Hebrides are of much the same character, but others, among them Mull and the greater part of Skye, are the remains of great lava sheets probably once continuous with the plateau of Antrim. The basalt columns of Staffa have their counterpart in the Giant's Causeway of Antrim.

The Northern Highlands and the Grampian Highlands are plateaus of ancient rock partially dissected by rivers and separated by the narrow valley of Glenmore. This valley is the result of a fault, and is now occupied by a series of lakes and streams which have been artificially connected to form the Caledonian Canal. The Northern Highlands are carved from an old peneplain, uplifted so that the surface had an easterly or south-easterly tilt. The higher elevations and the water-parting are therefore nearer the western than the eastern coast, and the streams flowing to the Minch are short and very rapid, while those flowing eastward are longer.

The ice-sheet of the Glacial Periods has greatly affected this

region: rocks are scratched and polished; in the valleys are many long lakes ("lochs") due to glacial action either in scooping basins or damming the valleys with morainic material; on the coasts are many fiords, which are submerged portions of similar glaciated valleys. Here, as on all the western coasts of Britain, a slight subsidence in comparatively recent times has resulted in the formation of a very irregular shore-line with many promontories and inlets.

The Grampian Highlands are very similar; the tilt of the original surface of the plateau was to the south-east and accounts for many of the stream-courses. Longer courses, however, are at right angles to this direction, e.g. those of the Findhorn, Spey and Upper Tay. These streams have cut their valleys in less resistant strata which crop out at the surface in south-west to north-east lines, i.e. the outcrop (see Fig. 34) or "grain" of the formations is from south-west to north-east. A few exceptional rivers, notably the Dee and the Don, flow eastward. The greatest heights are in the north-west; Ben Nevis overlooks Loch Linnhe from a height of over 4,400 feet, and near the source of the Dee several peaks rise above 4,000 feet. This region shows the same effects of glacial action as the Northern Highlands; lochs, however, are more common in the west than in the east, and the wetter west shows more strongly marked relief with steeper slopes and sharper peaks. Near Loch Lomond the scenery is particularly beautiful, and still more famed for its beauty is Loch Katrine.

At few points do the highlands reach the eastern coast. In Caithness there is a triangular lowland formed of Old Red Sandstone, of which the Orkneys may be regarded as detached portions. The same formation occurs on either side of Moray Firth and penetrates Glenmore. The lowland continues from Moray Firth eastward to the Buchan peninsula although most of this is formed of hard rock worn down almost to sea-level. It must be remembered that the formations here mentioned form the sub-soil not the soil, and in once glaciated regions the two may be very different. Moreover, large areas in Scotland are covered with peat, though in parts this has been removed and the new surface utilized for agriculture. The north-eastern coastal

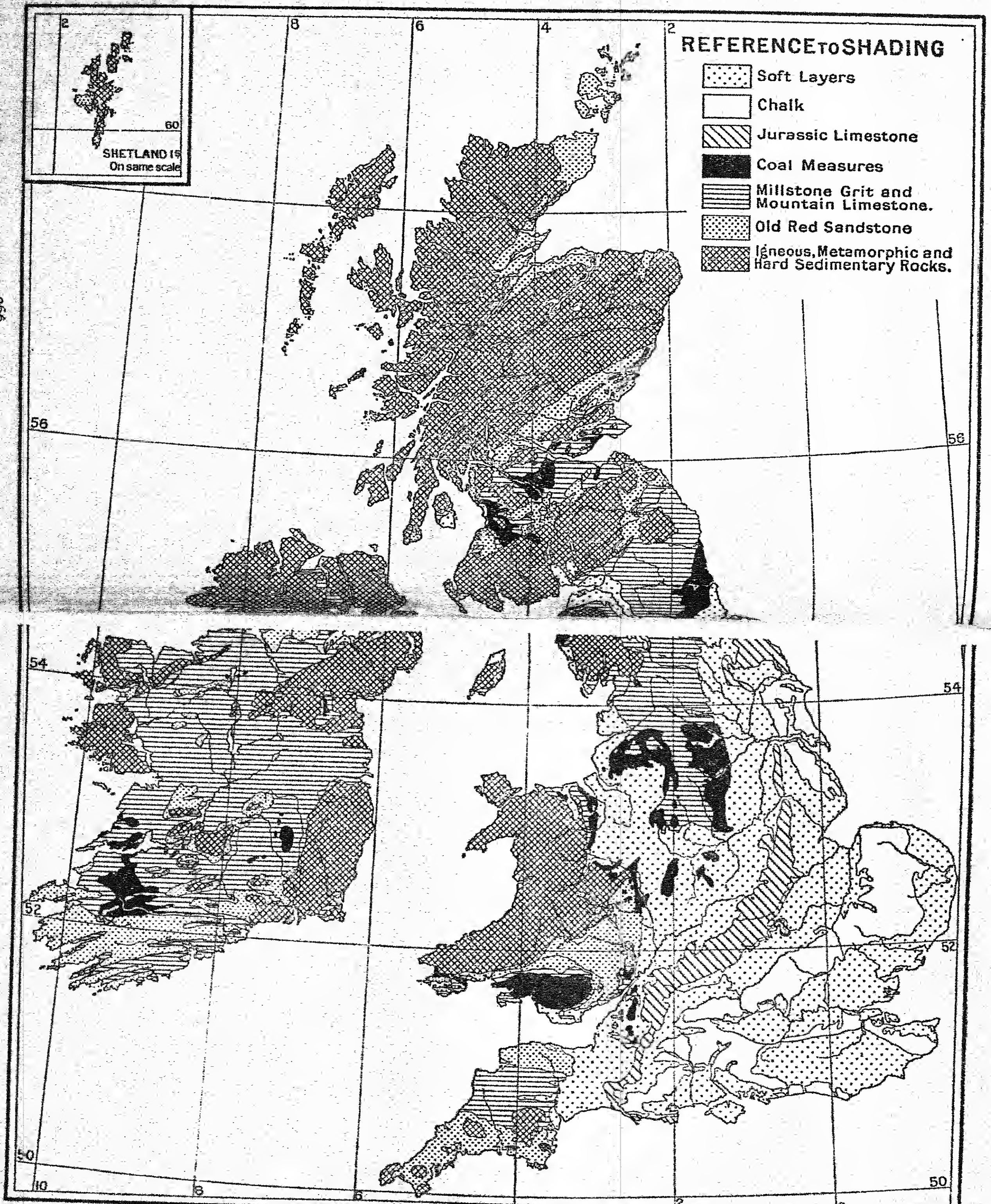


FIG. 118.—Simplified Geological Map of the British Isles.

plains are the most valuable parts of the Scottish Highland region; both agricultural and pastoral work are carried on, and the granite is quarried where it is found near the sea, particularly near Aberdeen and Peterhead. There are two main routes from the Central Valley to the north of Scotland. The "Highland" railway proceeds up the Tay valley in a north-westerly direction, which it retains, leaving the Tay and continuing up the valley of its tributaries the Tummel and the Garry. It then crosses the divide between the Garry and the Spey, and passes down the valley of the latter river until it turns again to the north-west to Inverness. Thence it runs northward along the eastern coastal plains, except where detours inland are made to avoid estuaries or difficult country. The other route is by Stonehaven and Aberdeen across the base of the Buchan peninsula to Elgin and thence by the coastal sill to Inverness.

The Central Valley.—The structure of this region may be understood by a comparison of the section in Fig. 119 with the map in Fig. 118. The ancient rock has been let down along parallel faults (F^2 and F^3) to form the floor upon which later deposits have been laid. These in turn have suffered faulting, folding and wearing, so that the present surface is neither level nor uniform in material.

Immediately under the Grampian edge lies a low, fertile plain of Old Red Sandstone worn down because of the softness of this formation.

To the south-east of this stretches a broken line of hills parallel to the faults, the Sidlaw Hills, Ochil Hills, Campsie Fells and the heights lying within the curve of the Clyde estuary. These are largely formed from resistant volcanic rock, through which the Tay, Forth and Clyde have worn valleys. Railway routes take advantage of these valleys as well as of the lowland between the Sidlaw Hills and the sea.

South-east of these hills is another low region, stretching from sea to sea. The subsidence has allowed the water to penetrate the land until the Clyde estuary is within 30 miles of the Forth. Here a downfold of Carboniferous rocks has been let down by a fault (F^4 in Fig. 119) and so preserved, for denudation has but little effect near sea-level. Of the Carboniferous

rocks the Coal-measures are the topmost series; they lie near the surface in the centre of the basin, and extend from the Clyde above Glasgow to north-east of the Forth near Clackmannan, this river merely separating two portions of the same coalfield. In England and Wales coal is obtained only from the Coal-measures, but in the Central Valley of Scotland workable seams are also found in the lower layers of the Carboniferous system; consequently the coal-mines of Scotland occur not only where the geological map shows Coal-measures but around and between these areas in parts where the map shows the other members of

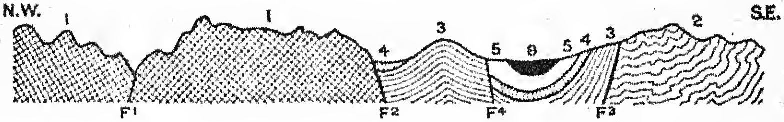


FIG. 119.—Diagrammatic Section showing Structure of Scotland from North-west to South-east.

(*Vertical scale exaggerated.*)

1. Hard rock of Highlands.
2. " " Southern Uplands.
3. Volcanic rock (formed in Old Red Sandstone period) of Sidlaw Hills, Ochil Hills and Pentland Hills.
4. Old Red Sandstone of Strathmore.
5. Carboniferous Limestones and Sandstones of the Central Valley.
6. Coal-measures of the Clyde-Forth coalfield.

F^1. Fault resulting in Glenmore.
F^2. " " Grampian edge of Central Valley.
F^3. " " Southern Upland edge of Central Valley.
F^4. " " lowering and preservation of coalfield.

the Carboniferous system, marked as Millstone Grit and Mountain Limestone.

There are two other coal-basins in the Central Valley: one occupies the lowland of Ayr; the other lies east of the Pentland Hills between the Southern Uplands and the Firth of Forth, and re-appears on the northern shore of the Firth east of Kirkcaldy. The geological map therefore shows two patches of Coal-measures in Fife, but coal is obtained also from all the region between them. In addition to the coal, oil (distilled from shale) and iron ore are produced. Between the coal-basins are uplands of harder rock of little value; of these uplands the Pentland Hills are typical.

The Tay flows from the Highlands into Strathmore, where it gathers a number of other streams from the Highlands; it then

passes through a valley between the Sidlaw and Ochil Hills which prolongs the line of the valley by which it left the Highlands. In all probability this course was determined ages ago when Old Red Sandstone filled what is now Strathmore, so that the Tay flowed across a peneplain from the hard rock of the Highlands crossing successive belts of sandstone and volcanic rock, and cutting a continuous valley across all the outcrops; afterwards the belt of softer sandstone was worn away leaving the more resistant rocks standing out on either side. A similar explanation applies to the valley of the Teith-Forth.[1] The direction of the Clyde is opposite to that of the Tay and Forth and has no parallel among the larger rivers of Scotland. It is probable that, as in the case of the other rivers, the Clyde once flowed to the south-east at a time when the northern part of the valley had not been eroded so deeply, and before the subsidence of the western coast occurred which altered the levels and caused its waters to flow in a reverse direction.

The Southern Uplands.—These are like the Highlands in being a partially dissected plateau with an original tilt to the south-east; hence the flow of many streams, e.g. the Esk, Annan and Nith, is to the south-east. Other rivers have carved out longitudinal valleys along the outcrops of various strata, e.g. the Teviot-Tweed and its tributary the Ettrick.

The greatest heights fall somewhat short of 3,000 feet, the upland area is penetrated by wider valleys than those of the Highlands, and in the west the Galloway peninsula is mainly lowland. On the east the Lammermuir Hills approach the sea at Dunbar, leaving but a narrow passage by means of which central Scotland is connected with England by the "East Coast Route." The uplands are crossed by three railway lines, one passing from the Tweed up the valley of the Gala Water (by Galashiels) to Edinburgh, another crossing from the Annan to the Clyde close by the Lowther Hills, and the third taking advantage of the

[1] The Teith, although commonly considered a tributary of the Forth, is in a line with the lower Forth and must be regarded as the parent stream; it is therefore convenient to indicate the main valley by combining the names of the streams.

Nith valley which almost connects the plain of Ayr with that around Solway Firth.

The Border Lands.—The lowlands around the Solway Firth have their eastern counterpart in those forming the Merse of Berwick by the lower Tweed and the coastal plain of Northumberland; between them are the Cheviot Hills, composed mainly of volcanic rocks and granite. These are distinct in structure from the Southern Uplands, but are joined to them by a ridge of high ground around the head-streams of the Teviot. Flowing south-westward from the Cheviot Hills to the Solway Firth is Liddel Water, whose valley is known as Liddisdale. On the eastern side the Cheviots are drained by three groups of streams: those flowing northward to the Tweed, those flowing eastward directly into the North Sea, and those flowing south-eastward into the Tyne. This river has two head-streams, the North Tyne from the Cheviots, and the South Tyne which flows from the south into the gap between the Cheviots and the Pennines known as the Tyne Gap. This gap connects the Solway plain with the coastal plain of Northumberland and Durham, at a level below 500 feet, thus affording easy communication in a direct west and east line between the respective centres Carlisle and Newcastle.

The Lake District.—South of Solway Plain is the Lake District, similar to the Cheviot Hills in being largely composed of volcanic rock, but older in formation, rising to greater heights (three peaks being over 3,000 feet high) and deeply cut by rivers radiating outward in all directions. The valleys contain a number of beautiful lakes, in many ways resembling those of the Scottish Highlands and like them due to glacial action. Of these Windermere is the largest, and Derwentwater and Bassenthwaite Water are worthy of mention as being the remaining portions of a single large lake partially filled by the alluvium brought down by small streams, so that the flat ground between the two existing lakes was gradually built up.

Between the mountains and the sea there is only a narrow strip of lowland; north-east of St. Bees Head this is formed of coal-bearing rock, from which some iron ore is obtained, while in the Furness district, the southern extremity of the coastal plain, large deposits of valuable hematite iron ore are found.

In the centre of the Lake District lead ore and zinc ore are mined, and some slate is quarried.

Separating the northern portion of the Lake District from the Pennines is the Eden Valley, which has a comparatively gentle slope from the west and is bounded by a much steeper slope from the Pennines. On this side there has been a fault which has let down the rocks from the level of Crossfell Edge on the east. This movement has preserved softer rocks in the Eden Valley, which in regard to fertility is therefore in marked contrast both with the region of hard rocks of the Lake District on the one side and with that of the Mountain Limestone of the Pennine Chain on the other. The southern portion of the Lake District is connected with the Pennines by Shap Fell at a height of 1,000 feet above the sea, over which passes the "West Coast Route" to Scotland on the way from the Lancashire coastal plain to the Solway lowland.

The Pennines and the Adjacent Plains.—From the Tyne gap the Pennine Chain stretches southward for about 120 miles. It is highest where Crossfell overlooks the Eden Valley from a height of nearly 3,000 feet, and from this edge the upland slopes eastward, drained in the same direction by the rivers Wear and Tees flowing independently to the North Sea.

South of Shap Fell the structure is that of an upfold formed of three layers. At the top were originally Coal-measures, below these Millstone Grit (well named, being of gritty material used for millstones and grindstones), and below this Mountain Limestone. The Coal-measures have been removed by denudation from the larger part of the region, remaining only at the four corners as shown in the geological map. In the north-west, beyond the Lake District, is the small coalfield already mentioned which extends to an unknown distance beneath the sea. In the north-east is the Northumberland and Durham coalfield, of which the seams dip eastward below the sea; this coalfield is far more valuable than its western counterpart. In the south-west is the coalfield of Lancashire and Cheshire, and farther to the south that of North Staffordshire; in the south-east is the York, Derby, and Nottingham coalfield which now produces more coal than any other in Britain. The section in Fig. 120

shows how these are now separated by the removal of the higher portions of the sheet of coal-bearing rock which once covered the whole of the Pennine area. The section shows also how all these layers forming the Pennine Chain dip down on either side till they are covered by the softer sands and clays which form the plains of Lancashire and Cheshire on the west and the Vale of York and the Trent Valley on the east.

In a corresponding way the rivers flow outward on either side, though their upper courses have a marked southerly trend. On

FIG. 120.—Diagrammatic Section from Snowdon to the Trent Valley.

(*Vertical scale exaggerated.*)

1. Hard rock of Wales from Snowdon eastward.
2a. Mountain Limestone and Grit of Denbigh.
2b. " " " " of the Pennine Chain (near Dove Dale).
3a. Coal-measures of the Flint and Denbigh coalfield (between Mold and Wrexham).
3b. " of the N. Staffs coalfield (near Burslem).
3c. " of the Notts coalfield (south of Chesterfield).
4a. Soft layers of the Cheshire Plain (near Nantwich).
4b. " " " Trent Valley (near Newark).

the west are the Lune, Ribble and Mersey, each with an estuary due to the submergence of the lower portion of the valley. On the east the rivers have cut a series of "Dales" which form roads into and across the upland. Of these dales the most important is that of the Aire, for it forms a narrow strip of lowland separating the Northern from the Southern Pennine Moors. The Aire gap is used not only for communication between Lancashire and Yorkshire, but by the "Midland Route" from southern and eastern England through the Eden valley to Carlisle and Scotland. From the Swale to the Wharfe the streams no longer flow independently to the sea but have been captured by the Yorkshire Ouse which developed along the soft formations of the Vale of York; this river also receives the water of the Aire and still lower in its course that of the Don. The Pennine Chain ends in the Peak District, for farther south its layers dip southward beneath the same sands and clays as those which flank it in Cheshire and Nottingham, here forming the region frequently known as the "Midlands." In the Peak District the Dales open

out to the south, and the Derwent, Dove and Upper Trent have been captured by the Lower Trent which has developed southward along the outcrop of the sands and clays. The Trent flows northward to join the Ouse, and the drowned estuary of the two rivers, known as the River Humber, therefore receives the drainage of a large portion of the Pennine region.

The Coal-measures that dip under the Cheshire Plain reappear on the borders of the Welsh Upland, and the three coalfields of South Lancashire, North Staffordshire and North Wales form one basin, although its centre is hidden beneath the softer deposits. By sinking shafts through these deposits the coal could be obtained, and this is done a little way beyond the outcrop on each side, but nearer the centre the depth becomes too great. In the same way and to a greater extent the coal is obtained from beneath the newer deposits on the eastern edge of the Pennines. After the more easily reached coal was obtained the miners were forced to go deeper and so the coalfields gradually extended farther and farther from the outcrop, and are larger than is indicated by the area of the Coal-measures on the geological map.

The Midlands.—It has been said that south of the Pennines the rocks dip under the newer deposits, and so form a floor on which these latter rest. The floor is not, however, level but in several parts bulges up so that the Coal-measures penetrate the newer layers and appear again at the surface. One such upfold in Leicester has produced the coalfield around Ashby; south-west of this, another upfold in Warwickshire has given rise to the coalfield between Tamworth, Nuneaton and Coventry; west of this, another upfold has formed the more important coalfield of South Staffordshire, extending from Cannock Chase through the Black Country; still farther west, in several places in Shropshire the coal rocks are bent up against the older rocks of Wales, as in the section in Fig. 120 they are shown to be farther north. Moreover, between all these outcrops, the coal rocks are preserved underneath the newer deposits, and shafts are sunk to reach them where the coal is near enough to the surface for the mining to be profitable.

The Coal-measures used to yield also iron ore, but little of

this is now obtained from any except those of Staffordshire, and this does not form a large proportion of the total output of iron ore. It is now only rarely that coal and iron are obtained from the same formation. Fire-clay is, however, still a useful product of the Coal-measures.

The region of the Midlands is therefore on the whole low and formed of fertile sands and clays, but it has rises which are associated with coal deposits, and in Charnwood Forest some very ancient igneous rocks come to the surface. The region is drained by streams which flow either to the Trent and hence to the north-east, or to the Warwickshire Avon and the Severn and therefore to the south-west. Between the south-west of the Pennine Chain and the hills of Shropshire, which extend eastward from the Welsh Upland, is a comparatively narrow lowland which has always been an important passage between the east and west of Britain and is called the Midland Gate.

For authorities and books for further reading, see end of Chapter XIX.

CHAPTER XVIII

THE BRITISH ISLES—*Continued*

SURFACE FEATURES, STRUCTURE AND MINERALS

Wales.—In many respects Wales resembles the Southern Uplands, for it is a dissected plateau composed of similar hard rocks. The highest part is in the north-west where the Snowdon Range reaches a height of 3,500 feet and immediately overlooks the narrow Menai Strait separating it from the worn-down island of Anglesey.

From this north-western region slates are obtained in great quantities and of the best quality. In North Wales also a little lead, zinc, copper, and even gold is obtained.

The Snowdon Range is continued in the Lleyn Peninsula, gradually becoming lower till it dips below sea-level. Parallel to this peninsula and forming the southern side of Cardigan Bay is the larger peninsula, ending in the county of Pembroke, which similarly becomes lower towards the south-west.

Between these peninsulas the sea reaches almost to the edge of the upland, with only a very narrow strip of lowland by the coast and a few narrow extensions up the valleys of the short rivers flowing seaward. On the northern coast of Wales there is another very narrow coastal plain, but the Clwyd and the Conway have rather wide valleys. A large portion of North Wales is drained eastward by the Dee, which, after bending round sharply, opens into a wide estuary parallel to that of the Mersey, and by the tributaries of the Severn which offer the easiest routes from England into central Wales.

Of these tributaries the Wye is the most important, for after leaving Wales it first traverses the fertile plain of Hereford and afterwards cuts through the plateau known as the Forest of

Dean, as it flows to the estuary of the Severn. This course of the Wye should be compared with those of the Tay and Forth where they cut the volcanic ridge of the Central Lowlands of Scotland after they have left the fertile plain of Strathmore. The plain of Hereford, as is shown in the section in Fig. 121, is similar to Strathmore, as it is formed of Old Red Sandstone laid down in a hollow between the Welsh Uplands on the west and the Malvern Hills and the Forest of Dean on the east. The parallel cannot be pressed too far, for the Forest of Dean is not a volcanic mass but a plateau formed mainly of Coal-measures arranged in the form of a complete basin surrounded by older rocks.

South Wales differs from North Wales on account of its structure. The old hard rocks of the north are here replaced by a great basin of coal-bearing rocks formed exactly like that of the Forest of Dean but much larger. A westward extension of this coalfield traverses Pembroke from Carmarthen Bay to St. Bride's Bay. The coal of South Wales is specially valuable; it includes anthracite, which burns with intense heat and little smoke, and the steam coal used for engines of warships. A fairly wide coastal plain lies between the uplands and the Bristol Channel, so that communication between England and Pembroke is not difficult, and a number of streams flow southward and have cut valleys which afford valuable roads between the coast and the interior. The Usk flows around the eastern margin of the coal-field, the Taff and the Tawe divide it into three almost equal portions, and the Towy encircles it on the west.

South-west England.—South of the Bristol Channel, Exmoor rises steeply from the sea to well over 1,000 feet. It is formed of rock which was laid down at about the same period as the Old Red Sandstone and is therefore marked as such on the geological maps, but it is composed of harder materials, namely slates, grits and limestones. South of Exmoor is the plain of Devon through which run the Taw and the Torridge to Barnstaple Bay on the north and the Exe to the greater bay on the south coast. Beyond the plain of Devon is the granite mass of Dartmoor, the highest points of which just exceed 2,000 feet. By the weathering and decomposition of the granite, china-clay or kaolin is formed, and is mined both in Devon and in the smaller

granite areas of Cornwall. Dartmoor is bounded on the west by the valley of the Tamar, and beyond this rise the Bodmin Moors. Farther to the south-west the ground is composed either of rocks such as those which appear in Exmoor or of granite like that of Dartmoor, but the peninsula becomes lower till it sinks beneath the sea to reappear, however, in the Scilly Isles about 20 miles from the mainland. Although Cornwall is mainly lowland it is bounded by cliffs, and its two projecting headlands, Land's End and Lizard Head, are due to hard masses which have withstood the wearing of the sea better than the less resistant rocks around them. In addition to the china-clay, granite and slates are quarried, and tin, copper and other minerals are mined. In regard to each of these products, Cornwall is of greater importance than Devonshire.

Between the Quantock Hills, which adjoin Exmoor, and the Mendip Hills lies the low flat plain of Somerset. This resembles the Fenland in being formed of alluvium and in having been reclaimed from a swampy condition; through it the Parret meanders to the Bristol Channel. The Mendip Hills both in structure and appearance recall the Pennine Moors. They resemble the Pennine region also in containing caves formed by the solution of the limestone by underground streams, and beautified by its precipitation in the form of stalagmites and stalactites coloured by traces of various minerals. The Cheddar Gorge is probably formed by the falling in of the roofs of a series of these caverns. The lead mining for which the Mendip Hills used to be famous is now practically non-existent.

The valley of the Severn is formed of the same sands and clays which are found in the Midlands. These extend to the south-west past the Mendip Hills, broken only by the emergence of these and of the Coal-measures at Bristol. The Bristol coalfield is like the neighbouring ones in being basin-shaped; it is crossed by the river Avon, which affords a waterway from the Bristol Channel.

The South-eastern Scarplands and Lowlands.—From the Mendip Hills there radiate north-eastward and eastward ridges of moderate relief which form the only exceptions to the rule that the east and south of England is a lowland plain. The soft

layers of the valleys of the Severn, Trent and Yorkshire Ouse dip eastward beneath layers such as form the Cotteswold Hills (see section in Fig. 121). These hills are composed of Jurassic limestone, which is sometimes distinguished by the term Oolitic, i.e. " Roe-stone," since it is composed of small round grains. The limestone layers also dip to the east, so that on the west their steep edge forms an escarpment overlooking the Severn valley from a height of about 1,000 feet, while on the east they slope gently to the Upper Thames valley. This scarped ridge is continued to the north-east first by the well-named Edge Hill overlooking the valley of the Warwickshire Avon, and then by

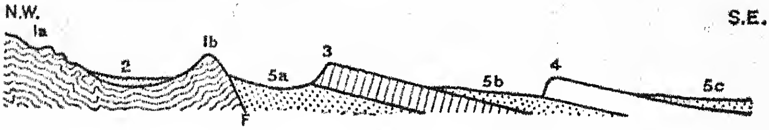


FIG. 121.—Diagrammatic Section from Radnorshire to London.

(Vertical scale exaggerated.)

1a. Hard Rock of Radnorshire.
1b. " " of the Malvern Hills.
2. Old Red Sandstone of the Plain of Hereford.
3. Jurassic Limestone of the Cotteswold Hills.
4. Chalk of the Chiltern Hills.
5a. Soft layers of the Severn Valley (near Tewkesbury).
5b. " " " Upper Thames Valley (near Oxford).
5c. " " " London Basin.
F. Fault which has let down the older rock beneath the Severn Valley.

the Northampton Uplands. These become lower as they bend more towards the north, and they then merge into the Lincoln Edge, which gradually becomes lower and narrower till it dies out before reaching the Humber. The Oolitic Limestone layers are not to be seen in the south of Yorkshire, but they reappear beyond the Derwent. There they extend from the Vale of York to the coast and their dip is on the whole from north to south; their highest portion is therefore on the northern rather than the western part and a large area is over 1,000 feet in height. The general name for this upland is the North York Moors, while the portion which overlooks the mouth of the Tees is called the Cleveland Hills.

There is no doubt that the limestone once extended much farther westward over the present valley of the Severn, Avon, Trent and Yorkshire Ouse, and that weathering and stream

action have worn it away exposing the sands and clays beneath. When that was accomplished, these agencies acted both on the softer layers, lowering the level of the plain and so to some extent undercutting the edge of the limestone, and also directly on the scarp of the limestone, gradually wearing it back eastward.

The Jurassic limestones are in several parts quarried for building stone, notably in the south at Bath and Portland, but a more valuable product is the iron ore, for about three-quarters of the total weight of ore raised in the British Isles is obtained from that part of the Jurassic belt which extends through Lincolnshire, Leicestershire and Northamptonshire, while less than one-fifth is got from the Cleveland district of Yorkshire. The total production of ore is increasing, but imports are necessary.

The limestone ridge dips eastward below layers of clays and sands (most of which are also Jurassic), worn down to form a hollow extending across England parallel to the limestone ridge. In the extreme south this hollow is not well marked, but east of the Cotteswold Hills it forms the Upper Thames Valley and farther to the north-east it broadens out into the lowland drained by the Great Ouse, the Nen and the Welland. Just as the limestone ridge becomes lower in this part of England so does this hollow, which here forms the Fenland. Across this the rivers wind until they enter the Wash, a portion of the hollow so low that it has been submerged by the waters of the North Sea. The Fenland has had to be drained and the soil is now formed of the alluvium brought down in the past by the rivers. They are now embanked and their work of drainage aided by the cutting of canals. North of the Wash the Jurassic hollow is drained by the lower course of the Witham after it has broken through the Lincoln Edge at the town of Lincoln, and north of the Humber it appears as the Vale of Pickering through which the Derwent flows to join the Yorkshire Ouse.

The section in Fig. 121 shows that the Jurassic hollow is bordered on the east by the steep scarp slope of the chalk ridge. Where it forms the Chiltern Hills this ridge has its escarpment facing the north-west and its gentle slope dipping to the south-east; in this respect the Chiltern Hills resemble the Cotteswold Hills, but they are considerably lower, scarcely attaining an

elevation of 800 feet. Farther to the north-east, where it forms the East Anglian Ridge, the chalk, like the limestone, becomes lower. From East Anglia it bends to the north-west and therefore towards the limestone, but this bending is not immediately apparent as the chalk is cut through by the Wash and is in part covered by alluvium before it rises to the surface again in the Lincoln Wolds. These extend, but at no great height, as far as the Humber, and beyond it the chalk scarpland is known as the Yorkshire Wolds which rise to about the same height as the Chiltern Hills and end in the white cliffs of Flamborough Head.

The chalk, like the Jurassic limestone, once extended far to the west of the present escarpment, probably to the Pennine and Cambrian uplands, covering the lower layers and forming a plateau dipping gently from the uplands eastward. The higher western part of this great sheet of chalk has been worn away and the present scarped edge is still being cut back very slowly.

The chalk country is extensive in the south of England, for the Chiltern Hills are continued at their south-western end by the White Horse Hills, sometimes called the Marlborough Downs. The Chiltern Hills and White Horse Hills are separated only by the narrow gap worn out by the Thames. Thus the great curve of the chalk ridge has been cut through by three rivers: the Thames, the Humber and a river into which the Wash rivers united before the sinking converted its valley into an inlet of the sea.

The White Horse Hills are separated by the Kennet valley from the wide chalk upland known as Salisbury Plain, which appears on the map as a centre from which the chalk ridges radiate to the north-east, to the south-west and to the south-east. To the south-west the chalk forms a scarpland in all respects similar to that already described, and on the south-east it is first continued in the Hampshire Downs and then apparently splits into two portions, the North Downs ending in the South Foreland, and the South Downs ending in Beachy Head.

The section in Fig. 122 shows that these are also ridges with their escarpments facing one another; if the chalk that forms

the South Downs and slopes upward from the English Channel is imagined to continue past its present scarped edge along the course of the dotted lines, it will be seen to join the chalk which forms the North Downs. Farther to the north this same sheet of chalk dips below other layers which hide it from view in the neighbourhood of London, and then rises and comes to the surface again as the Chiltern Hills. Thus the chalk which appears on the map as distinct ridges was originally one sheet, bent up into an anticline in the part south of the lower Thames and bent down again into a syncline in the part now known as the London Basin.

The anticline has the chalk removed from the top and the layers beneath it have been exposed, forming the country known as the Weald. Moreover, the bending was of a dome-like character, so that there was not only an upfold from north to south but also an upfold from east to west, and this accounts for the eastward-facing escarpment of the Hampshire Downs. The form of the whole arrangement resembles an oval with the south-eastern portion lacking, and beyond the Strait of Dover the extreme end of this portion is found in France. The chalk cliffs of Dover correspond with those of Calais, the South Downs have their counterpart in the chalk of Picardy, and the layers exposed between the North and South Downs are found also between Calais and Boulogne. From these and other facts it is concluded that the dome extended from England into France joining Britain to the Continent, and that the chalk ridges of south-eastern England are not only essentially one, but form part of the broader chalk country of north-western Europe.

Smaller patches of chalk also are found in south-east Britain. The Isle of Thanet is due to a small up-bending of the chalk beyond its north-eastern dip from the North Downs under a strip of softer rock; this patch accounts for the chalk headland of the North Foreland. Precisely as the chalk of the Chiltern Hills dips under the soft layers in the London Basin and reappears in the North Downs, so the chalk of Salisbury Plain and the Hampshire Downs dips under the soft layers of the Hampshire Basin and reappears in the Downs of the centre and south of the Isle of Wight. The lowest part of this Basin has been covered

by the sea, forming Southampton Water and the straits Solent and Spithead.

The Test and Itchen flow to Southampton Water, while further west the chalk country is drained by converging streams, the Salisbury Avon, the Stour and the Frome.

The drainage of the Weald is from the centre outward, having been determined at the time when the dome-form was complete and the streams radiating outwards cut channels in the chalk.

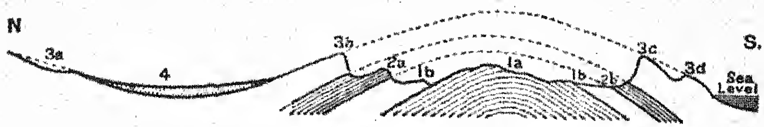


FIG. 122.—Diagrammatic Section from Hertford southward to near Brighton.
(Vertical scale greatly exaggerated.)

1a. Wealden Sands (forming Ashdown Forest).
1b. „ Clay.
2a. Greensands with Gault Clay (east of Redhill).
2b. „ „ „ „ (near Ditchling).
3a. Chalk (near Hertford).
3b. „ of the North Downs (south of Croydon).
3c. „ „ South Downs (Ditchling Beacon).
3d. „ Cliffs (east of Brighton).
4. Soft layers of the London Basin (near London Bridge).

Now that the centre of the area has been worn down the streams still maintain their direction and the chalk scarplands both on the north and on the south are cut by their valleys. The channels of the Arun and the Ouse breach the South Downs, while those of the Wey, Mole and Medway lead through the North Downs to the Thames Valley, and the Stour has cut a gap further east and flows independently to the sea.

Just as these chalk scarplands of the south have channels cut deeply into them, originating at a time when the chalk extended beyond the present scarps, so the scarplands north of the Thames, both limestone and chalk, are trenched by valleys. Most of these lead south-eastward, for the rivers flowed in that direction down the dip-slope of the old land-surface. The upper Thames receives the Windrush and the Cherwell from the limestone ridge, the lower Thames receives the Colne and Lea from the Chiltern Hills, while from the chalk of East Anglia the Yare, Waveney and other streams flow over the low coastal plains to the sea. Both north and south of the Thames these gaps through

the ridges and others in which no rivers now flow, are utilized by the railways which radiate from London in all directions.

Ireland.—It has been pointed out that to a large extent the structural divisions of Ireland are prolongations of those of Great Britain. The mountains of Donegal and Connaught repeat most of the characteristics of the Scottish Highlands, but the highland areas are less extensive and the elevations are lower, nowhere reaching 3,000 feet. As the North Channel has separated Scotland from Donegal, so Donegal Bay separates the latter region from Connaught.

The south-west trend of the Southern Uplands of Scotland is discernible in the granite Mourne Mountains, and is followed also by the Slieve Bloom and the heights in northern Tipperary, though the structure is not continuous through the central plain of Ireland.

The rift valley which is apparent between the Highlands and Southern Uplands of Scotland is scarcely to be traced in Ireland, for it is hidden by the basaltic plateau of Antrim. The coal of Scotland is here represented only by a small deposit in Tyrone, and a little iron ore is also obtained from this region. The drainage system, too, has been modified by the outpouring of basalt, and Lough Neagh, the largest lake in the British Isles, occupies a hollow formed by the faulting and subsidence of a part of the basalt.

The mountains of Wicklow are similar to those of North Wales but are more largely composed of granite; this is quarried and some copper is also obtained.

The mountains of Munster are the highest in Ireland; here the ridges are composed of hard rocks formed in Old Red Sandstone times; the grain of the land (shown by the river valleys and estuaries) is in a general east-west direction, as is that of South Wales and the south-western peninsula of England. The scenery is beautiful, the Lakes of Killarney, which lie close to the highest ridges (Macgillicuddy's Reeks), attracting many tourists.

The lowlands of Ireland are largely formed of limestone, which in England has been upraised and is therefore called "Mountain Limestone," but in Ireland lies in horizontal sheets

over large areas. Over much of this Coal-measures were once spread, but these have been denuded except in one or two places where, by folding, they have been preserved in "basins." The chief of these is near Carlow, west of the Wicklow Hills, where coal is to some extent mined. In the south-west of Ireland, the geological map shows Coal-measures, but coal itself does not occur in these parts.

Ireland, in common with Great Britain north of the Thames, has been subject to glacial action and its surface has been widely covered with drift deposits. Moreover, there are large bogs, in some of which peat has formed in great masses. This peat is dug and dried for use as fuel, both coal and wood being scarce. The flatness and solubility of the limestone have allowed water to dissolve the rock in certain parts where it accumulated, and so to form shallow lakes which are characteristic of the rivers of the Irish Plain.

The Shannon is the largest river ; unfortunately for its value as a means of communication, its estuary opens to the Atlantic, away from Britain, but where it leaves Lough Derg it gives water-power for electricity used in all parts of Eire. In the south, the Blackwater, Lee and Bandon flow in valleys between the east-west ridges, but near their mouths turn southward through gaps in the ridges. These gaps probably represent the original courses of the rivers, the east-west streams having subsequently developed along the belts of less resistant rock which now form the valleys. Long reaches of the Barrow, Nore and Suir also lead southward, an east-west development having caused the waters of the upper Suir to join those of the Barrow and Nore above Waterford Harbour.

The Liffey and Boyne flow eastward over the plain where for a stretch of 50 miles the lowland adjoins the Irish Sea ; here, therefore, there is a wide natural entry into Ireland from Great Britain. The scattered nature of the uplands allows communication to be carried on through the country by many routes, and no part of Ireland is so isolated by the relief of the land as are portions of the Scottish Highlands.

For authorities and books for further reading, see list at end of Chapter XIX.

CHAPTER XIX

THE BRITISH ISLES—*Continued*

INDUSTRIES AND TOWNS

Since the localization of industries is largely determined by natural resources, a study of the occupations of the people may be conveniently made in regard to regions which have distinctive physical conditions, taking into account such factors as position, relief, structure, minerals and climate.

Northern Scotland.—North of the fault-line separating the Highlands from the Central Valley, much of the land is upland and the summer temperature is nowhere high; the region has no minerals to serve as a basis for manufactures and its position is not favourable to commerce. The population is therefore scanty, the lowlands of the north-east being the only exception to this rule. In these lowlands climatic conditions are more suitable for agriculture than in the remaining areas, for the temperatures are higher, the rain is less, and the sky being less often cloud-covered the amount of sunshine is greater; moreover, much of the sub-soil is the fertile Old Red Sandstone and the soil itself has been improved by past generations of farmers. This district is therefore an agricultural one, and cattle are reared in considerable numbers. The quarrying, shaping and export of granite affords occupation for some of the inhabitants of Aberdeen and Peterhead, but at these towns, as well as others such as Wick in Caithness, fishing and the curing and export of fish are also important industries. The largest town is Aberdeen, by the mouths of the Dee and Don, where the East Coast Route connects these lowlands with those of the Central Valley; considerably smaller is Inverness, in the most central position, whence Glenmore leads to the western coast.

The river valleys prolong the coastal lowlands into the upland regions, but the highlands themselves have few inhabitants. To a small extent they are used as grazing lands, but they largely consist of cotton-grass and heather moors, large areas of which are preserved as deer-forests and grouse-moors for the "sport" of visitors. These and other parts attract tourists by their beauty, and a small permanent population is dependent upon these visitors from more southerly parts of Britain.

The people of the western coast and islands engage in fishing, and to a less extent in agriculture and pastoral work. The only town of importance is Oban, at the south-western end of Glenmore, which serves as a centre for coasting vessels.

The Central Valley of Scotland.—This is by far the most important part of the country; most of it is densely populated and two-thirds of the whole population of Scotland is found in this relatively small area. With the exception of the volcanic masses the ground is favourable to agriculture, Strathmore being exceptionally fertile. Here, as farther north, the climatic conditions of the east encourage cultivation more than those of the west; Fifeshire and the Lothian counties south of the Firth of Forth are more productive in both cereals and green crops than any other parts of Britain except eastern England, and the Carse of Gowrie between the Sidlaw Hills and the Firth of Tay is noted for its fruit, as is Blairgowrie district in Strathmore.

As affording a basis for population, the minerals are even more important than the agricultural products. The coal annually produced in this region is about one-sixth of the whole amount annually raised in Britain. The Ayr coalfield also yields iron ore, and in consequence has iron-smelting and the making of iron and steel goods; at Ayr shipbuilding is carried on, and at Kilmarnock engines and machines are constructed. Still greater quantities of coal and iron are obtained from the Clyde-Forth coalfield, especially in the county of Lanark. The iron ore is now insufficient for the manufactures, and both to this and to the Ayr district more ore is imported from Spain than is produced locally; Glasgow, Coatbridge, Motherwell and Hamilton in the Clyde valley, and Falkirk near the Forth are the chief centres of the iron and steel industry. The lower Clyde is the greatest

shipbuilding district in the world ; at Greenock and Port Glasgow and on both banks from Dumbarton to Glasgow there are shipbuilding yards.

The same coalfield is the seat of an important cotton industry, for the facility in obtaining raw material from America and the dampness of the air have aided Paisley to produce sewing-thread, and Glasgow to make other cotton goods. The making of woollen goods, the manufacture of chemicals and the refining of sugar are also carried on in this region.

On the eastern shores of the Central Valley the coal is utilized for other purposes, at Dundee and Dunfermline in the manufacture of linen from flax imported from the Baltic region, and at Dundee and Kirkcaldy in the making of sacking, oil-cloth and other fabrics from jute imported from India ; at Dundee also the making of jam was based upon the fruit grown in the Carse of Gowrie, and to this industry the making of marmalade has long been added. The waters of the Tay are specially suitable for the dyeing and bleaching works of Perth.

As a consequence of the agricultural, mining and manufacturing activities, trade and transport are important. The subsidence which has allowed the sea to flood the lower valleys and thus reduce the possibilities of agriculture has afforded to commerce convenient entries into the heart of the country; moreover, the Forth and Clyde canal provides water communication from sea to sea. The Clyde has been canalized to enable the ocean-going vessels to reach Glasgow, which stands where the river was easily crossed. Being in the centre of the industrial area and yet in touch with other lands, this city has become the commercial capital of Scotland and in size the second city in the British Isles, for its population numbers over a million people. The trade of the district is also shared by smaller cities nearer the mouth of the river, among them being Greenock and Port Glasgow.

On the east coast, the greatest trade passes through Leith, the port of Edinburgh. Edinburgh is built around the castle, set upon a hill (an old volcanic "neck") which commands the East Coast Route into Scotland. This city was the capital of the Scottish kings and still remains the seat of government. Grange-

mouth is a smaller port farther up the estuary. To facilitate railway travelling along the east coast, the estuaries have been bridged, the Forth Bridge being situated at the narrowing above Edinburgh, and the Tay Bridge crossing the river at Dundee. Important railway centres are Perth at the Tay gap through the volcanic ridge, and Stirling at the corresponding Forth gap. The present importance of these cities as traffic centres corresponds to their ancient importance in warfare; each had its castle, and near Stirling is the site of the battle of Bannockburn.

Southern Scotland.—The uplands of southern Scotland are used for little except grazing, some of the eastern counties having a greater number of sheep to the square mile than are found in any other part of the British Isles except Wales; cattle are relatively unimportant. The sheep-rearing was one factor in the growth of the woollen industry of the Tweed valley, where the good water was another advantage. In spite of the absence of coal, the manufacture of "tweeds" and knit-wear flourishes at Galashiels, Hawick and other smaller centres in the east, and at Dumfries on the Nith in Solway Plain. Agriculture and dairy farming are carried on in the coastal lowlands and valleys.

The Pennine and Cumbrian Uplands.—Only in the valleys of these regions is agriculture possible, and sheep-rearing and quarrying are almost the only occupations of the extremely scanty population of the uplands. In the summer they are visited by tourists; the Lake District is one of the most beautiful parts of England, and Keswick is a well-known centre. The great rainfall supplies water for a number of large cities of the neighbouring lowlands, reservoirs being built or natural lakes being used for storage; Manchester draws its water from Thirlmere in the Lake District, and the other cities from valleys in the Pennines.

The Coalfields.—The margins of the uplands are the coal-producing regions and in consequence have important industries, great populations, and large cities.

The Cumberland coalfield is one of the smallest of the English coalfields; some of the coal is employed to manufacture iron at Workington, but most of it is exported from Whitehaven and Maryport; much of it is used in the Furness district of Lancashire which lies about 30 or 40 miles to the south-east, where

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the hematite iron ore is the basis of an important iron and steel industry. The centre of this industry is Barrow, whose position on the coast has led to specialization in shipbuilding, but several other branches of the industry are carried on and other manufactures have more recently developed.

The Northumberland and Durham coalfield is also largely connected with the iron industry, for although very little iron is obtained in the immediate vicinity, that from the neighbouring Cleveland district can be cheaply brought by sea, while on the other hand, a part of the coal raised from this field is sent to the Cleveland district to be used there. In addition there is a considerable export of coal both by sea and rail to London. The population is largely grouped around the lower courses of the Tyne, Wear and Tees. Tynemouth, North Shields and South Shields stand at the mouth of the Tyne, Jarrow is a few miles up the river, and beyond that Newcastle and Gateshead face one another on either bank. At the mouth of the Wear is Sunderland, and on or near the Tees are Darlington, Stockton and the two Hartlepools. On each of these rivers, and especially on the Tyne, shipbuilding is carried on, this region coming second to the Clyde in this respect. The products of the iron and steel industry are numerous; the locomotives built at Darlington may be specially mentioned. In addition to its manufactures Newcastle derives importance from trade, for it is one of the large ports of the country.

The York, Derby and Nottingham coalfield ranks first in regard to production, yielding about one-third of the whole amount. It extends from Bradford and Leeds in the north to Derby and Nottingham in the south, Sheffield occupying a central position. On this coalfield the industries are more varied, but those connected with iron and wool stand in the forefront. Iron is obtained chiefly from the Jurassic limestone on the east, or from abroad; it is used at several towns for the making of machinery for the woollen and other manufactures, and in Sheffield there is the noted cutlery industry, to which electro-plating has been added. Sheffield developed its manufacture of cutlery not only because of the local coal and iron, but because it could obtain the grindstones in the neighbourhood; it now makes some of

its best products including machine-tools with iron obtained from Sweden. At Doncaster and Derby are large railway works.

The woollen industry grew up in the valleys of the West Riding of Yorkshire largely because of the streams which provided water for cleaning and dyeing the wool, and power for the machinery; moreover, the neighbouring hills served as sheep-runs. Later, the possession of coal ensured prosperity to this region, and at present the woollen manufacture is far more important here than elsewhere in Britain. Bradford, situated immediately south of the Aire, is the chief centre for worsted yarns and goods, in addition to silks, velvets and plushes; a few miles farther to the south in the Calder valley lie a group of cities with woollen industries, Halifax, Huddersfield, Dewsbury, Batley and Wakefield, with Barnsley still farther to the south-east.

Leeds is the largest city of this region, with about half a million inhabitants. It stands where the Aire valley enters the Plain of York, and is the centre of the woollen trade, being specially concerned in the making of ready-made clothes; it produces iron and steel goods, boots and shoes, and has many other industries. The ports which are particularly concerned with the foreign trade of this region are Hull, Goole, Immingham and Grimsby on the Humber, and Liverpool on the Mersey, but most of the imported wool first passes through London.

In the extreme south-east of this coalfield stands Nottingham, on the Trent. This city engages in the making of lace and hosiery from cotton and artificial silk. This is the only branch of the cotton industry carried on in the drier parts of Britain, and its localization in the east is possible because the threads used are stronger and less liable to snap in a dry atmosphere than those used in other branches of the work.

The Lancashire and Cheshire coalfield has a less annual production than those on the eastern slope of the Pennines, but it supports the greatest manufacturing industry of Britain—that of cotton. The advantages which led to the growth of the cotton industry in Scotland are found here also; indeed, Lancashire is nearer to the raw material, to the great population of southern Britain, and to the chief markets abroad, namely, the eastern Mediterranean region, India and the Far East.

Manchester is the great centre of the cotton industry, but it engages in trade even more than in manufacturing. To facilitate the import and export of goods the Manchester Ship Canal has been constructed, enabling large ships to reach the city, though most of the cotton is still unloaded at the port of Liverpool. Adjoining Manchester is Salford; the two cities are really one centre of industry and trade and may therefore be described as Manchester-Salford. Besides the great warehouses and offices there are spinning-mills and weaving-sheds; Manchester-Salford has also a growing industry in electrical and general engineering, and its combined population now numbers nearly one million.

Cotton spinning is carried on at many places, the greatest production being at Oldham, Bolton, Rochdale, Preston, Ashton, and Stockport (in Cheshire). The weaving is localized chiefly in the north of this district, the greatest number of looms being at Burnley, Blackburn, Preston and Bury. At Rochdale, Bury and elsewhere woollen goods are also manufactured, and silk goods at Macclesfield in Cheshire. At a number of places machinery for the textile industries is made; Wigan is a coal-mining and iron-smelting centre; Widnes and St. Helens have great chemical works, and the latter city is noted for its glass-making; a number of miscellaneous factories are situated at Warrington.

Although beyond the coal-mining area, Liverpool, with Birkenhead on the opposite side of the Mersey estuary, belongs essentially to this district, for it has grown with the development of the coalfield. It is the second port of Britain; it exports most of the manufactured cotton goods and much machinery, and imports not only the cotton for the Lancashire factories, but supplies of meat and wheat which come from America to be distributed over a large part of Britain. Flour-milling is therefore an important industry, as is soap-making from imported "oil-seeds," e.g. palm-kernels. The combined population of Liverpool-Birkenhead is about one million.

The North Staffordshire coalfield specializes in the making of pottery. The neighbouring clays afforded the raw materials in earlier times and still do so as far as the coarser kind is concerned. The finer materials and also the flint which is required are now brought from a distance; kaolin is conveyed from

Cornwall and Devonshire by sea to the Mersey and thence by canal. The district is known as "The Potteries"; Stoke-upon-Trent is the largest centre.

Near this coalfield but in the plain of Cheshire is Crewe, a railway junction which has great works for the construction of locomotives and rolling-stock, and for general engineering.

The North Wales coalfield has but a small output. There are no large towns on the coalfield and the coal is used for various works at Chester, Mold and other places on or near the Dee.

The Midland coalfields are four in number, and together produce about as much coal as Lancashire. The Leicester coalfield lies in the north-west of the county around Ashby. Near it is Burton-on-Trent with its brewing industry; the coal is also sent to the town of Leicester, where there are manufactures of woollen and silk hosiery and also of boots and shoes, the leather being in part obtained from the cattle which are reared in large numbers on the plain around Leicester. The Warwickshire coalfield supplies coal to Coventry, where the staple industries are the making of motor-cars, bicycles, and artificial silk.

More important is the South Staffordshire coalfield; there is now little coal and no iron ore produced, but "geographical inertia" has maintained an industry of finished steel goods in the "Black Country." On the coalfield itself stand Wolverhampton, Walsall, Wednesbury, Dudley and West Bromwich, and at its margin is Birmingham, a city of about a million inhabitants, with many manufactures, especially those of arms, engines, tools, motor cars and bicycles. Situated in the centre of England, this district is relatively far from the sea, and, moreover, no large river flows through it. Canals have been constructed from the Mersey, Trent, Severn and Thames, and the situation is excellent for the various home markets. Kidderminster, which lies to the south of this district, makes carpets and other textiles. In Shropshire there are small coalfields, but no important cities are associated with them.

The South Wales coalfield has mining and metal industries. Iron ore is imported from Spain and smelted at several places at and near Swansea at the mouth of the Tawe and Port Talbot. The chief activities are in the west, connected with mining of

anthracite and working of steel, particularly making "tin-plates"—thin steel sheets covered with tin, lead or zinc, and greatly needed for the food-canning, motor-car and other industries. Swansea is the centre and chief port of the western area. The coal mining and iron working of the east has declined, but there are steel works at Ebbw Vale, and Cardiff at the mouth of the Taff still retains manufacturing and an export of coal.

The Bristol coalfield has a very small production of coal, which is used in the varied industries of Bristol and its neighbourhood. These industries include tobacco-manufacturing, cocoa-making and sugar-refining, the raw materials being largely obtained from the West Indies and America, with which Bristol has traded for generations. This port was once the second in the country, but its trade, together with that of its outport, Avonmouth, is now relatively small, particularly in regard to exports.

Wales.—With the exception of the districts around the coalfields, Wales is not densely populated, for it is mainly an agricultural and sheep-rearing region, with some quarrying and mining. The agriculture is carried on in the coastal lands (including Anglesey) and the river valleys; there are great numbers of sheep on the uplands, and this has led to some manufacture of flannel and other woollen goods in the valleys, as at Newtown and Welshpool on the Severn. Slate is extensively quarried behind Bangor and Carnarvon on the Menai Strait. The coasts and the interior are alike visited by tourists in summer. Holyhead in the north and Fishguard in the south are packet stations whence short crossings to Ireland may be accomplished, and at Pembroke, on Milford Haven, there is a naval dockyard.

The rainfall of the uplands serves for the needs of English towns, the valleys of the Vyrnwy and of a tributary of the Wye having been dammed up so as to form water reservoirs for Liverpool and Birmingham respectively.

The South-western Peninsula.—Cornwall and Devon are agricultural counties, for the southerly position allows the people to grow vegetables and flowers earlier than in most of the country, and for this reason they can obtain high prices which compensate for the cost of sending the goods a long railway journey to the big centres of population; cider-apples and other

fruits are also important products. Exeter is the natural centre of the richer lands of Devonshire. The moors are very scantily populated and most of the people live along the south coast, where fishing is added to agriculture as a means of subsistence. Mining and quarrying are other resources of these counties, but the ancient tin industry is now at a standstill. On Plymouth Sound stand Devonport, a naval and military station with a naval dockyard, and Plymouth where ocean-liners call with the mails, which can be carried more quickly by train. Here the clothing and engineering trades flourish.

The English Scarplands.—After the Pennine and Cambrian Uplands, these are the least populous parts of England. Their thin soils are unfavourable for agriculture, and on the ridges the exposed position combines with the dryness of the ground and its lack of plant-foods to make cultivation difficult. Pasture therefore predominates, and sheep are far more numerous than cattle. In the Cotteswold region the sheep-rearing aided the growth of a woollen industry, where " West of England broadcloth " was made. This industry is still carried on in Stroud in Gloucestershire, and at Trowbridge and Bradford in Wiltshire. Where the Avon has cut a gorge through the escarpment stands Bath, whose warm mineral springs have for centuries made this a famous inland watering-place. In this neighbourhood and elsewhere in the limestone ridge, the quarrying of the stone affords work for a scattered population.

In the north of the Jurassic belt the iron of the Cleveland Hills has given rise to the smelting and manufacturing industries of Middlesbrough and Tees-side. South of the Humber the ore is in part sent to the neighbouring coalfields to be smelted, but very much is used in large steel works at Scunthorpe and Frodingham in Lincolnshire and at Corby in Northamptonshire. At Lincoln, which is built in the gap where the Witham breaks through the ridge, agricultural implements are made, and at Northampton and Kettering a great boot and shoe industry is situated.

The chalk country is not only poor from the agricultural point of view, but has very little value in respect of minerals. The chalk and flints are quarried, but do not afford the basis of

any important industries. Where the chalk dips to the lowlands the soil is frequently of a richer character, and such areas are more used for agriculture. In the neighbourhood of London, the slopes of the Chilterns and the North Downs are farmed to meet the demands of the metropolitan population for dairy produce and vegetables.

The English Lowlands.—The lowlands which have no coalfields are mainly characterized by two occupations; their fertility encourages agriculture, and their level surface and the extent to which the sea has invaded the lower parts of the river valleys encourages commerce. A coalfield with iron ore lies deeply buried beneath the later strata in East Kent, near Dover; the cost of working is heavy and as yet the field has not been greatly developed, but it supplies Dover.

In the south-east the commerce is chiefly related to the position of London. The Thames and the Thames valley have always been the main roads from the Continent into Britain. The nearest landing places, Sandwich, Deal, Dover, Hythe, Hastings and others are on the south side of the estuary, while the more important parts of the country are on the north; hence a crossing is necessary, but broad alluvial flats, covered at high tide and swampy at low tide, made the passage impossible below the site of London Bridge. Here, then, was the first crossing, and from this point roads radiated in all directions. The bridge also prevented vessels going farther up the river and so London became the chief centre of foreign trade. The fact that the south-east was the important part of England in former times, and that roads connected London with all this important part made it the most convenient seat of government. With the industrial and political development of Britain, London has developed. London has a population of about 8 millions, and the trade of the lower Thames, known as the "port of London," is greater than that of any other British port. To meet the local needs and with facilities for export, many industries especially those producing small articles have grown up, so that "Greater London" has become the largest manufacturing area in Britain.

Immediately adjoining London are several large boroughs such as West Ham and Croydon, and many other towns in south-

east England have their importance largely determined by their relation to the metropolis. Thus Newhaven, Folkestone, Dover and Harwich are at the seaward ends of routes leading from London to various parts of the Continent. Portsmouth on the South Coast and Chatham at the mouth of the Medway are great naval dockyards placed in inlets where they may be used by fleets defending the capital from attacks from the south and east. The large port of Southampton derives no small part of its trade from the London district or from the capital itself, and many watering-places, such as Yarmouth and Brighton, cater largely for visitors from London. Even Canterbury, with its ecclesiastical associations which would seem to have little in common with the commercial metropolis, owed its importance to its position on the Stour where Roman roads converged from several landing places to follow one route to London.

The agricultural products of the lowlands vary mainly according to climatic differences and local demand. In the dry eastern counties the summer sun and heat facilitate the ripening of corn crops and especially wheat, while the central and western plains have much meadow-land on which cattle are kept. In the south fruit is more largely grown than in the centre or north, the Wealden portion of Kent and the plain of Hereford being specially notable in this respect; in these two counties hops are also grown. Sugar beet is important in East Anglia.

Many market towns have grown up on the rivers which traverse the lowlands, and some of these have become large towns for special reasons: Oxford and Cambridge first developed in consequence of their universities. The former manufactures motor-cars, the latter wireless apparatus. At Reading biscuit-making and seed-raising are important, Bedford and Ipswich have machine works, and at Norwich mustard, boots and sweets are manufactured. Other places have become railway centres, such as York in the centre of the Vale of York, on the road to the north, and Swindon on the route to the west.

Many places along the coasts are fishing stations; Grimsby and Yarmouth are specially important in consequence of their position between the Dogger Bank and the great centres of population.

Ireland.—Cattle-rearing and agriculture are by far the most

important occupations of the people of Ireland. Except in the extreme west, there are more cattle to the square mile than in almost any other district in Great Britain; the number of sheep to the square mile is considerably less than in the other divisions of the United Kingdom (see table on p. 259), but the proportion of pigs is greater, and large numbers of horses are bred. Consequently cattle and horses are sent to Great Britain, and butter and bacon are important exports. Over a large part of Ireland, and particularly in the west, the productivity of the land is slight and the farmers are very poor.

In the north-eastern province of Ulster, the industries are more varied, the population is greater, and poverty is not so general. Agriculture yields a better return, more land being devoted both to green crops, including potatoes, and corn crops, and flax is grown. This flax (together with that imported from the Continent) is used for the manufacture of linen in several towns, but chiefly at Belfast on Belfast Lough, at Lurgan, and at Londonderry. At Belfast there is also a considerable ship-building industry, for which the coal and iron are obtained from Great Britain. Other manufactures and much trade are carried on at Belfast, the seat of the government of Northern Ireland; this city has almost equalled Dublin in size and has nearly half a million inhabitants.

Dublin is in a favourable position for the seat of government of Eire, for it is on a bay centrally placed on the coast facing Great Britain, and communication with any part of the country is easy; its industries include brewing, whisky-distilling, and the making of clothing, furniture and food-stuffs.

The only other towns of importance, like those already mentioned, are ports; Waterford stands on the Suir near its junction with the Barrow, Limerick is at the head of the estuary of the Shannon, and Cork is built where the Lee enters Cork Harbour. The last-mentioned city is the largest in the south of Ireland, and in its harbour is an island on which stands Cobh (Queenstown), where Atlantic liners call with mails to be sent by railway across Ireland, by boat across the Irish Sea, and thence by railway again to various parts of Great Britain. There are three quick routes connecting Ireland with Great Britain: from

Larne in Antrim to Stanraer on Loch Ryan, where the Galloway peninsula causes the North Channel to narrow to less than 30 miles; from Dun Laoghaire (Kingstown) on Dublin Bay to Holyhead on Holyhead Island, west of Anglesey; from Rosslare immediately south of Wexford Harbour to Fishguard in Pembroke.[1]

Foreign Trade of the British Isles.—The foreign trade of Britain is enormous, for so much of the manufacturing is for foreign markets, and in payment both raw materials and food are received.

Four-fifths (in values) of the exports consist of manufactured goods. When these are arranged in classes, cotton goods are the most valuable, and not much less important are the many forms of iron and steel goods, including machinery. Much less quantities of woollen and other textiles are exported, and next to these come various chemical products; among the manufactured goods, ships should be included, for the shipbuilding yards of Britain send out many ships to sail under other flags. The only important export besides that of manufactured goods is that of coal.

The imports may be divided into three groups: food, drink and tobacco form the largest of these, accounting for over two-fifths of the total; goods for manufacture (i.e. either raw materials or articles which have undergone but a small part of the manufacturing process) comprise about one-third of the total; manufactured articles amount to about one-quarter of the whole.

Among the imported food-stuffs, animals and meat are the most valuable, closely followed by grain and flour. Butter, cheese and eggs form another large class, and a fourth group includes tea, coffee and sugar. Wine, oranges, bananas and tobacco are a fifth important group.

Of the raw materials, cotton and wool are the chief, and

[1] A very useful exercise for revision would be to study a railway map of the British Isles in connexion with the text of this chapter and a map showing the relief of the country. The *main* line of each of the *principal* railways might be traced out, and its course explained with reference to the physical features (e.g. highlands, valleys, and estuaries) and to the industrial regions and centres which it serves. The facts as to routes, junctions and works given in conjunction with each of the various regions described above may thus be brought together.

next come oil-seeds, nuts, oils and fats; wood and timber; rubber. Flax, hemp, jute and various ores are of less value. Actually the oils, seeds, nuts and fats, formerly utilized for soap, lubricants and similar manufactures, are now partly used to make butter and lard substitutes, although they are not classed as food-stuffs. Hides and skins are an important class.

The imported manufactured articles are of many kinds, metal goods other than iron and steel being of the greatest value, followed by machinery and the group including chemicals, oils, drugs, dyes and colours.

Canada and the United States are the chief sources of wheat and wheat-flour, followed by Argentine, Australia and India, in the order named. Of the meat supplies, beef comes in great quantities from the Argentine, bacon and other pork products from the United States and Canada, mutton from New Zealand and Australia.

Cotton, less important than formerly, comes mainly from the United States, as does a large proportion of the import of petroleum, of tobacco and of copper. Australia, New Zealand and British South Africa supply a large proportion of the raw wool from overseas. Egypt supplies fine cotton.

The Channel Islands.—Geographically these islands are detached portions of Normandy; the people also are Norman and French is the official language. The islands formed part of the dominions of the Duke of Normandy when he conquered England, and have since remained under the British crown although they have their own laws. The largest islands are Jersey, Guernsey, Alderney and Sark. The climate is mild and sunny, and early vegetables, flowers, fruit and dairy produce are exported to London. St. Helier is the port.

AUTHORITIES AND BOOKS FOR FURTHER READING.

Dr. M. Epstein (Editor): *The Statesman's Year Book* [Annual] (Macmillan).
H. J. Mackinder: *Britain and the British Seas* (Oxford Press).
A. G. Ogilvie (Editor): *Great Britain* (Cambridge Press).
A. Demangeon: *Les Iles Britanniques* [Tome I—*Géographie Universelle*] (Colin: Paris).
J. F. Unstead: *The British Isles* (University of London Press).
H. Ormsby: *London on the Thames* (Sifton, Praed).
Ll. R. Jones: *Northern England* (*Routledge*).
L. D. Stamp and S. Beaver: *The British Isles* (Longmans)

CHAPTER XX

EUROPE—PHYSICAL CONDITIONS

POSITION

Europe is a very irregularly shaped land-mass with an area of 3,700,000 square miles, so that it is the smallest of the continents with the exception of Australia. As regards latitude, it extends roughly from 35° N. to 71° N., lying therefore almost wholly within the temperature zone and reaching only 4½° beyond the Arctic Circle. If a great circle is drawn upon the globe separating the land from the water hemisphere, Europe is found to occupy a central position on the former.

It may be looked upon as merely a peninsular extension of Asia, for it is united to this continent by a land boundary about 3,000 miles long, and tapers westwards towards the Atlantic with no abrupt change of conditions. The greater elements of the European relief, its plains and mountain chains, are a prolongation of those of Asia, the climate of the one continent passes insensibly into that of the other, and the plants and animals afford no striking contrasts.

The close union of Europe with south-western Asia and north-eastern Africa led to a spread of the early culture of the Nearer East, at first through the Mediterranean lands, and later through central and western Europe. The continent is now the home of the most highly civilized peoples in the world, and is foremost in industry, commerce, science and art.

On three sides Europe has water boundaries, on the north the Arctic Ocean, on the west the Atlantic Ocean, and on the south the Mediterranean Sea. In addition to this, it is penetrated by inland seas, so that except in eastern Russia no part of the land is more than 400 miles from the coast. Its situation on

the eastern margin of the Atlantic gives it great climatic advantages. It is also excellently placed as regards sea-routes. The Mediterranean gives access to the Far East, the Atlantic to Africa, and also to the eastern shores of the Americas where the great natural routes to the interior of these continents are found.

BUILD

Outlines of Relief.—Europe falls into three broad divisions as regards relief. The north-western highlands bordering on the deep Norway Sea rise in places above 6,000 feet. The central plains and uplands rarely rise above 3,000 feet; with them may be associated the shallow North and Baltic Seas less than 100 fathoms deep. The southern mountains rise over 6,000 feet and sometimes over 12,000 feet, while on their borders are the deep basins of the Mediterranean, Black and Caspian Seas.

Outlines of Structure.—Four of the principal structural divisions of the world are represented (see Fig. 55). (1) An ancient peneplain of crystalline rocks borders the Gulf of Bothnia. (2) The great Russian platform is built of nearly horizontal undisturbed sedimentary rocks which form a plain stretching from the Arctic Ocean to the Caspian Sea. (3) A series of blocks and basins occupy the western and central regions, whose history is very complicated. Here, at different ages, fold-mountains reared their crests; these were worn down to their foundations, forming peneplains, but subsequent earth movements fractured these peneplains, uplifting some areas and depressing others. The uplifted areas formed upstanding blocks which have been much dissected by the various agents of erosion, while the depressed areas have been filled with the sedimentary deposits of later ages. (4) The region of fold-mountains occupies the southern part of the continent. The process of intense folding by which these mountain chains were raised up was accompanied or followed by a series of fractures, leading to the subsidence of large blocks on the margins of the folds. As a result the mountains sweep round great depressions such as the Hungarian and North Italian Plains and the Mediterranean basins.

Soils.—Large areas are covered with soils laid down during

the Ice Age (see Fig. 33). In the north-west, where the ice-sheet was thickest, areas are found with the rocks scraped bare of soil, but over the greater part of the once ice-covered region, the ground moraine of boulder clay is still found, while the successive resting-places of the edge of the ice-sheet are marked out by lines of low hills, the ancient terminal moraines. The lighter fragments of the glacial drift have been carried beyond the regions of actual deposit, partly by water but also largely by wind, forming a very fine soil, similar to the loess of China. The greatest loess deposits are in southern Russia, but they also extend westwards along the southern edge of the plains as far as Normandy, and are found round the Alps and Carpathians, which were also extensively glaciated and yielded their own morainic deposits. In parts of Russia, Hungary and Rumania, the loess is mixed with a large proportion of humus and forms the Black Earth, noted for its fertility. On the north Alpine foreland many of the old moraines have been partly spread out by later water-action; these moraines, like those of the plains round the Baltic, form a poor sandy or gravelly soil.

Many of the upland regions are formed of granite or sandstone which yield unfertile soils, or of limestone which yields a very thin soil, but usually there is such a great variety of outcrops that a fertile mixed soil gradually collects in the valleys. Extinct volcanoes are found in Central France, the Rhine Uplands, the Upper Weser basin and round the Hungarian plain, and their lavas also contribute to the formation of fertile soils.

In depressed regions bordered by steep mountains the abrupt change of slope checks the streams and leads naturally to an abundant deposit of alluvium; the North Italian plain, the Hungarian plain and the lower Danube are examples of this.

Many of the soils of Europe are, however, largely artificial, the result of centuries of cultivation. Poor soils have been rendered fertile by manuring, stony soils have been gradually cleared, and bogs, flood-plains, and marshes have been drained and reclaimed.

The North-western Highlands.—The different regions may now be considered in more detail. The North-western Highlands

occupy the western part of the Scandinavian peninsula. This region consists of an uplifted block tilted south-eastwards, which thus rises abruptly from the Norway Sea, and more gradually from the Swedish peneplain. Owing to the protective covering of the ancient ice-sheet, and the persistence of large snow-fields, such as the Dovre Fjeld and Jötun Fjeld, even to the present day, parts of the plateau have been preserved from erosion, and still keep much of the appearance of the ancient peneplain. The river divide, which lies near the high western margin, is flat and therefore ill-defined, so that on it lie lakes and swamps which drain both to the Norway Sea and to the Baltic Sea. The western margin has been much fractured, and the innumerable islands (the Lofoten Group, and the fringe known as the Skerry Guard), are the fragments of an older land-mass. The great glaciers which came down from the ice-sheet to the sea have given the characteristic fiord features to the indentations along the coast (see p. 76). The chief openings are the Trondhjem, Sogne and Hardanger Fjords. Along the eastern margin of the plateau the glacier-deepened valleys contain long narrow lakes, drained by parallel streams to the Baltic Sea. The rivers have a general south-easterly direction, following the slope of the plateau, but the chief of them, the Glommen, bends southward and enters the Skagerrak. The Highlands of Scotland, which correspond physically and structurally with these Scandinavian Highlands, are separated from them by the depression which forms the opening between the Norway and North Seas. From the Shetland and Orkney Islands, which partly close this opening, a submarine ridge (the Faroe-Icelandic Ridge) stretches across to Greenland. On this ridge stand the Faroes with their surrounding banks, and Iceland, which is largely built of lava and has numerous geysers, hot springs, and volcanoes, of which Hekla is the best known.

The North-western Seas and Central Plains.—The shallow seas of the north-west are really submerged portions of the Central Plains. The North Sea opens to the Atlantic by the Strait of Dover and the English Channel. Currents sweep into it by its southern and northern entries, and according to the season it is filled to a greater or less extent with the warm salt waters of

the Atlantic Drift. Among its shallows and deeps, well known to fishermen, the Dogger Bank and the Silver Pits may be mentioned.

The Baltic Sea is almost shut off from the North Sea by the peninsula of Jutland and the neighbouring islands. It has no tides. Owing to the abundant rainfall of the region, the small evaporation, and the number of large rivers entering the sea, its waters are comparatively fresh and there is an outflowing surface current through the Kattegat and Skagerrak. Below this current there is an under-tow by which the North Sea waters enter the Baltic, while at certain seasons there is even an increep of cold Arctic waters along the bottom. Such mixtures of waters as are to be found in the North and Baltic Seas seem to favour an abundance of fish. A depression stretching across Sweden, in which lie lakes Mälar, Vetter and Vener and the river Göta, is the relic of an older outlet of the Baltic. A second depression, in which lie the Gulf of Finland, the River Neva, Lakes Ladoga and Onega, and an arm of the White Sea, almost links the Baltic to the Arctic Sea. This depression marks the southern boundary of the ancient peneplain of crystalline rocks bordering the Gulf of Bothnia. The Finnish portion of this peneplain shows in an especial degree the effects of glacial action. In the rock hollows scooped by the ice, and among the irregular morainic deposits, lie innumerable lakes, while many bare rock surfaces, polished and scratched, are to be seen.

Along the southern shores of the Baltic, the currents and waves have drifted the sand into long bars and spits, some of which enclose or partially enclose lagoons. These lagoons are being gradually silted up with the débris brought both by the sea water and the rivers which enter them. The most important are the Frisches Haff and the Kurisches Haff, into which the Vistula and Memel respectively are building deltas. Not far from the coast the land rises to a line of low heights covered with glacial deposits and studded with numerous lakes. Parallel to these heights, and to the south of them lie depressions which once carried the melted waters from the edge of the ice-sheet westwards to the sea. They are now occupied successively by parts of the great rivers of the North German plain and their

tributaries. The most northerly contains a tributary entering the Vistula from the east above Bromberg, the Netze, short lengths of the Warthe and Oder respectively, and then the lower Elbe. After the ice left the Baltic, the Vistula and Oder found an outlet northward, breaking through the line of the Baltic Heights; the lower Elbe still follows this great depression to the North Sea.

The plain which borders the North Sea, stretching from Jutland to Calais, is also covered with recent deposits, some of glacial origin, and others brought down by the Rhine and Maas, which have gradually built up fresh land along the shallow borders of the sea. The coasts of these lands are low and sandy, and are bordered by natural sand-dunes and artificial dykes. They are unstable, and the land, much of which (owing partly to the settlement of the soft material) lies below sea-level, is liable to flood. The Zuider Zee was invaded by the sea in the thirteenth century, and is now being reclaimed. The Frisian Islands mark the line of the old dune coast before this great encroachment.

The plains are continued south-westward by the Paris basin. This region is covered with sedimentary rocks of unequal resistance, which have been carved by erosion into a series of scarped ridges, the dip-slopes being towards Paris. The structure is similar to that of the English Plain, Paris occupying a position comparable with that of London. The greater part of the area is drained by the Seine, which collects the waters from the hills to the north-east, east, and south-east; the most important streams are the Oise, Marne, Seine and Yonne, of which the first three meet in the neighbourhood of Paris. The Loire, coming from the south, also at one time joined the Seine, as the direction of its upper middle course suggests, but the formation of a depression to the west allowed it to find an easy route into the Bay of Biscay. Owing to this former union of the two rivers, there is no hilly divide between the Loire and Seine basins, and the region drained by the Middle Loire and its tributaries forms, both by its origin and the present relief of the land, a part of the Paris basin.

The meanders of the lower Seine are cut down into a low

chalk plateau. This shows that after the Seine had formed its flood-plain the region underwent a slight uplift. Chalk cliffs like those of southern England are a feature of the coast. This basin is connected by the Gate of Poitou with that of the Garonne.

The Garonne basin with that of its tributary the Dordogne is also filled with sedimentary rocks, while more recent accumulations of sand form a flat strip fringed with brackish lagoons along the coast; this latter region is known as the Landes. The sand, first deposited by the sea, has been blown inland by the wind. The northward trend of the Garonne estuary indicates the northward set of the currents which have helped to build up this coast.

The Russian Plain.—The Baltic plains are continued eastward by the Great Russian platform. This platform was once partly bordered by fold-mountains, of which the Ural Mountains prolonged into Nova Zembla are the remains, as are also the old rocks which crop out in the Donetz basin in South Russia. On this vast plain is found the largest river of Europe, the Volga. It rises in the Valdai Hills, which barely exceed 1,000 feet in altitude, and flows first eastward, receiving the Oka and the Kama, and then southward. On reaching the level depression which borders the Caspian Sea, it becomes encumbered with sandbanks and breaks up into several channels, finally entering the sea by a large delta. The Caspian Sea was formerly of much greater extent, and its retreating waters have left a desolate plain dotted with salt lakes, which is below mean sea-level. Before turning south-eastward to the Caspian depression, the Volga approaches within fifty miles of the Don, which makes a similar elbow-bend to the south-west and with the Donetz enters the Sea of Azov. Farther to the west the Dnieper after draining the vast Pripet marshes empties its waters into the Black Sea. A line of low heights separates the basin of the Volga from that of the Northern Dvina, a large and deep river which flows to the White Sea The Düna is the most important river draining to the Baltic Sea.

The Central Uplands.—These consist mainly of upstanding blocks of old crystalline or sedimentary rocks which show very

little order or arrangement among themselves. In the west of France such a block, the softer parts worn to valleys and the harder left in relief, forms the hilly region of Brittany and Normandy. The trend of the outcrops of rock is from west to east and the ends of the ridges run out to sea as promontories while the drowned ends of the valleys form rias. Numerous small islands remain as relics of a former more extended land-mass.

The Central Plateau of France is mainly built of old crystalline rocks. The uniform level of the flat rounded summits suggests its origin, namely, that it is an uplifted and re-dissected peneplain. The eastern border, seen from the deep depression of the Saône-Rhone valley, has the appearance of a mountain range, and is called the Cevennes in the south, the Côte d'Or farther north. To the west, in the Causses region, the plateau is composed of permeable limestone. Here it is bare and waterless, the rivers, such as the Lot and Tarn, flowing in deep cañon-like valleys, which have been mentioned (see p. 67) as characteristic of a limestone country. To the north, the highland is drained by the deep broad parallel valleys of the Allier and Loire, which once, as has already been described, entered the Seine. That this central region was once the seat of great crustal disturbances is shown by the partially destroyed cones of extinct volcanoes (known as the Puys) and by the great lava-flows which are found in the Auvergne region.

Between the southern border of the Central Plateau and the Pyrenees is an opening known as the Gate of Carcassonne, which gives access from the basin of the Garonne to the Mediterranean border and the Rhone depression. The latter river flows swiftly down its narrow valley, and enters the Lion Gulf by a large marshy delta, studded with lagoons.

North-eastward of the Saône valley lie the Vosges Mountains. These and the Black Forest once formed a single block, the central part of which has been let down along a series of parallel faults so as to form a narrow trough or rift-valley. This valley has been filled with later sediments, and is now drained by the river Rhine. An extinct volcano, the Kaiserstuhl, on the floor of this valley, is witness to former crustal weakness and instability. The Burgundian Gate gives access from the Saône-

Rhone depression to this rift-valley, while the Pass of Zabern or Col de Saverne [1] leads into it from the Paris basin. After passing through this wide alluvium-floored valley the Rhine turns sharply west and then north-west, and enters a narrow winding gorge. The river has itself cut this gorge, maintaining the slope of its bed while the surrounding land-mass was gradually uplifted. The uplifted block, largely composed of schists, is known as the Rhine Massif. Various parts have received different names, the Hunsrück, Taunus, Westerwald, Eifel and Ardennes. There is abundant evidence that these uplands are the remains of an old uplifted peneplain. The uniform level of the flat summits, and the deeply incised meanders of the Mosel, which is tributary to the Rhine, may be mentioned. The Massif is famous for its extinct volcanoes and crater lakes. Along its northern margin lie two important valleys, that of the Sambre-Meuse on the one hand, that of the Ruhr, a tributary of the Rhine, on the other. Both are rich in coal.

The Fichtel Gebirge (Pine Mountains) in central Germany form a convenient centre round which several upland masses may be grouped. To the north-west extends the Thuringian Forest, a narrow block bordered by almost parallel faults. To the south-west are the Franconian and Suabian Jura, scarped ridges of limestone and sandstone, presenting steep slopes to the west, but having long gentle slopes to the east which show a general plateau-like character. These scarp lands are drained by the Neckar and Maine, tributaries of the Rhine.

East of the Fichtel Gebirge is the Bohemian "diamond," a block of ancient rocks now partly covered by later sediments. It is bordered by picturesque uplands built of granite, hard sandstone and crystalline schists: the Bohemian and Bavarian Forest Mountains to the south-west, the Erz Gebirge or Ore Mountains to the north-west, the Sudetes to the north-east, and the comparatively low Moravian heights to the south-east. The block forming the Erz Gebirge shows a very marked fracture line and presents a steep face towards Bohemia, while sloping away gradually towards the German plain. The well-known thermal springs of Karlsbad and Marienbad lie south of this fracture line.

[1] This is a narrow pass west of Strasbourg.

The rivers which drain the greater part of Bohemia are gathered up by the Moldau and this in turn joins the Elbe. It is remarkable that, instead of crossing the low Moravian Heights, these waters make their way northwards by a deep narrow gorge between the lofty Erz Gebirge and Sudetes. The explanation is that the Elbe flowed out northwards before these masses were uplifted, and as the land rose the river kept pace with it by progressively deepening its bed. It may be noticed that the Oder for a considerable distance runs parallel to the Sudetes, while the Danube, which at first has the same direction as the Suabian Jura, i.e. from south-west to north-east, turns sharply and runs south-eastwards crossing a corner of the Bavarian Forest into which it cuts a rocky gorge. The general direction of the Sudetes reappears north-westwards in the isolated block of the Harz Mountains. This uplifted block is much dissected, and a resistant granite mass has formed the Brocken, a summit famous in German legend. A similar direction is found in the Weser Heights, a long hog's-back ridge, across which the Weser has cut an important gap known as the Westphalian Gate which affords access from the Ruhr basin to the North German plain. The Weser drains the irregular hilly country between Thuringia and the Rhine Massif, finally crossing the German plain and entering the North Sea not far from the Elbe.

The Southern Mountains and Basins.—In the South European mountain region the Iberian Peninsula may be compared, as regards its structure, with the block mountains of France and Germany. The main mass, known as the Meseta, is a triangular block of old rocks. Its base lies along the Atlantic coast, its north-eastern edge forms the steep heights overlooking the Ebro basin, its south-eastern edge forms the Sierra Morena, overlooking the basin of Andalusia, in which the Guadalquivir flows.

Granite rocks, long exposed to erosion, form the irregular mountainous country of Galicia. Here there is a well-marked ria coast. Farther to the south-east similar rocks, owing to their resistant powers, have been left as an upstanding ridge, the Sierra de Guadarrama, which runs from east to west and separates the two level stretches of Old and New Castile. Old Castile is drained by the River Douro, which as it leaves the plateau edge

falls by a series of rapids through deep gorges to the Atlantic coastal plain. The Tagus and the Guadiana, separated by the hard ridge of the Toledo Mountains, also drain the plateau westwards and show the same contrast, their upper courses placid and tame, their lower courses turbulent and picturesque.

The Ebro basin, overlooked on the south by the steep edge of the Meseta, is bordered northwards by fold-mountains running from west to east, the Cantabrian Mountains and the Pyrenees. A chain of mountains bordering the coast closes the eastern end of the basin, but across this chain the Ebro has cut a narrow winding gorge through which it flows encumbered by rapids. The Pyrenees, which in France rise almost wall-like from the basin of the Garonne, descend less abruptly on the Spanish side. A central granite core forms an almost unbroken ridge, so that in all its length there is no easy pass from north to south. Easy access from France to Spain is by the narrow sills between the extremities of the chain and the sea.

The basin of Andalusia, once a gulf of the Atlantic Ocean, is the chief lowland of Spain. It is drained by the Guadalquivir, the only river in the whole peninsula which winds with a uniformly gentle slope down to the sea. A second chain of fold-mountains, the Sierra Nevada, borders this basin to the south. Tracing the course of this chain from the south-eastern corner of the peninsula, it is seen that the direction of the folds is at first from east to west, then from north to south, so that they cross from Spain to Africa, and then from west to east. The north-south part of the chain is cut through by the Strait of Gibraltar, but a submarine ridge at this point still partly shuts off the Mediterranean from the Atlantic, and has the important effect of keeping out the cold bottom waters of the ocean. These folded mountains of north Africa, known as the Atlas Mountains, are prolonged through Sicily into Italy where they form the Apennines, so that they partly outline the Western basin of the Mediterranean. The Tyrrhenian Sea is shut off from the larger part of this basin by the islands of Elba, Corsica, Sardinia and Sicily, the first three islands being relic blocks of a sunken land-mass. The straits of Messina and of Sicily give access to the Eastern Mediterranean. The curved fracture line which forms the south-eastern

border of the Tyrrhenian Sea is still the seat of crustal disturbances. On or near it are the active volcanoes of Vesuvius, Etna and the Lipari Islands, and in 1909 it was visited by a disastrous earthquake. The Balearic Islands, farther to the west, are (like Corsica and Sardinia) fragments of a land-mass which has sunk beneath the waters.

The Apennines are perhaps the youngest mountains in the world. They are nowhere very lofty, and are drained by rivers which run parallel to the fold-lines, mainly from north-west to south-east, and then turn sharply towards the sea, the longest being the Arno and Tiber. The most important pass over the Apennines is the low Bocchetta Pass, which leads from the north Italian plain to the Mediterranean border. To the west of this pass the Apennines merge into the Alps which sweep northwards and then north-eastwards, forming the broadest and loftiest belt of the fold-mountain system in Europe.

The Western Alps consist mainly of gneiss and crystalline schists on the Italian side and limestones on the French side. They are drained eastward by the head-streams of the Po, among which the Dora Riparia may be mentioned, while among the rivers flowing westward the Isère and the Durance, both tributary to the Rhone, are important. The western rivers are remarkable for their sudden changes of direction, as they flow alternately at right angles and parallel to the axes of folding. The origin of such rivers has already been suggested (see p. 72). The chief summit in this region is Mont Blanc (15,800 ft.); the most important pass, that of Mont Cenis (6,880 ft.), lies between the valley of the Dora Riparia and that of a tributary of the Isère. It gives access from the Italian plain to the Rhone Valley, and thence to northern France.

The Central Alps also consist of a crystalline belt rising abruptly from the Italian plain, and a less imposing limestone belt to the north. They are trenched by a remarkable longitudinal valley containing the headwaters of the Rhine flowing north-eastwards, and those of the Rhone flowing south-westwards. Both these rivers afterwards make sharp bends and cut transverse valleys through the limestone Alps. From a point close to the sources of the Rhone and Rhine, the valley of the Reuss leads

northwards and that of the Ticino southwards; between the valleys of these two rivers is the famous St. Gotthard Pass (6,900 ft.), affording the chief north-south route across the Alps. From the upper part of the Rhone valley the Simplon Pass (6,600 ft.) leads to the Italian plain. Immediately to the north of this valley lies the Bernese Oberland on which is the great Aletsch Glacier, and near it the Jungfrau, a peak famous for its beauty.

The Eastern Alps are separated from the Central Alps by the Engadine Valley, containing the upper waters of the River Inn. In this section there are three zones, a central one of crystalline rocks, bordered to the north and south by limestone ranges. A longitudinal valley, containing successively portions of the Inn, Salzach and Enns rivers, separates the crystalline from the northern limestone Alps. All these rivers bend suddenly northward and crossing the Alpine Foreland join the Danube. Two parallel longitudinal valleys are occupied by the Mur and the Drava, also tributaries of the Danube. The loftiest masses of the central crystalline zone form the Hohe Tauern, on which there are a number of large glaciers. The chief pass is the Brenner (4,500 ft.), which gives access from the Inn to the valley of the Etsch or Adige opening to the Italian plain. From the Inn valley the Arlberg Pass leads westwards to the Rhine. The direction of the upper valley of the Mur is continued by that of the Mürz which leads, by way of the Semmering Pass to the depression known as the Vienna basin. This basin separates the Alps from the Carpathians.

Throughout the Alps many of the characteristic features are due to the present glaciation, and to the more extensive ice-covering of the Glacial Periods. Trough-shaped valleys, water-falls and deep lake-basins may be traced to ice action. A fringe of ice-scooped lakes borders the mountain region: Como, Maggiore, and Garda lie along the south; Geneva, Thun, Brienz, Lucerne, Zurich and Constance to the north.

To the north of the Alps lies a broad belt of hilly country known as the Foreland. It extends from Lake Geneva north-eastward to the Bavarian Forest, and is drained by tributaries of the Rhine and Danube. Rock waste of glacial origin

covers it almost entirely, and these irregular deposits, by obstructing the drainage, have caused the formation of lakes and marshes.

The Jura Mountains, which consist of a very regular series of parallel ridges and furrows, are separated from the Alpine Foreland by the depression containing Lake Neuchatel and the lower Aar. In these mountains there is a general correspondence of the valleys to the down-folds of the rocks and the ridges to the up-folds. This is not the case in the Alps where the folding has been greatly complicated by fractures and over-thrusts. The Jura Mountains shut in the Alpine Foreland to the west, leaving only narrow lines of communication between it and the Saône-Rhone depression on the one hand and the rift-valley of the Rhine on the other.

Embraced by the Alps and the Appennines is the depression drained by the Po. This river carries so much silt that it has raised its bed above the level of the surrounding country and is kept in its course by natural levees and artificial dykes. It is building out a large delta into the shallow northern Adriatic Sea. This part of the Adriatic is merely an extension of the plain, and its low northern and western shores are bordered by islands, lagoons and marshes.

The direction of the eastern shore of the Adriatic is parallel to that of the Dinaric Alps, a part of the fold system running from north-west to south-west. These mountains consist largely of permeable limestones, and hence swallow-holes, into which streams disappear, and underground rivers characterize the region, and over large areas no surface water is to be found. Farther south the Pindus Range has a north-south direction, which is also repeated by the coast-line. This shore of the Adriatic gives its name to the Dalmatian type of coast-line, in which the mountain chains are parallel to the coast, and through erosion, fracture and subsidence the outer ridges have been transformed into long, narrow, hilly islands.

The Pindus Range is continued in the finger-like promontories of Morea, and may be linked up through the mountains of Crete and Cyprus with the Taurus Range in Asia Minor.

The Ægean Sea has a very irregular coast and is dotted over

with a rocky Archipelago. Here an old land-mass has disappeared, leaving these fragmentary remains.

The river Vardar flowing southwards to the Ægean Sea, and the Morava flowing northwards to the Danube form a natural route from north to south across the Balkan Peninsula. The chief features of the region to the east of these rivers may be grouped about the mountain basin of Sofia. To the south-east rise the Rhodope Mountains, an irregular mass carved by erosion from an old block of crystalline rocks; from the north-western margin of the Sofia basin a tributary flows to the Morava; on its south-eastern margin the Maritza takes its rise. This river flows through the basin of Philippopolis, then through a narrow valley into the basin of Adrianople, and thence to the Ægean Sea. All these basins, together with the Sea of Marmora, are formed by the sinking of crustal blocks along lines of fracture below the general level of the surrounding land-masses. The Sofia basin itself is drained by the Isker which cuts a narrow precipitous gorge through the Balkan Mountains and flows to the Danube.

In the Balkan Mountains the great fold system of south Europe reappears. This range may be traced from east to west, then it makes a bend northwards, and finally eastwards, where it forms the Transylvanian Alps which run parallel to the Balkan chain. Between the two mountain ranges the Danube has cut a gorge, the Iron Gate; here the river makes its way by a series of rapids between steep and lofty walls of limestone rock. Below the gorge the Danube is bordered on the right bank by a low limestone plateau, rising somewhat steeply from the river, on the left by a level plain floored with alluvium brought down partly by the Danube itself, but mainly by its tributaries from the Transylvanian Alps. Here, too, are loess deposits, probably formed from the glacial waste from the same mountains. The limestone plateau extends northward along the Black Sea coast forming the district of Dobruja, and the river here makes a sharp bend northwards round the edge of the plateau. All along its low left bank the Danube forms a series of marshes, lagoons and secondary channels, finally entering the Black Sea by a large delta. From this lower plain of the Danube the Shipka Pass leads southward over the Balkans to the basin of Philippopolis, while the Red

Tower (Rotenthurm) Pass is one of the chief routes northwards into Transylvania. This hilly basin is embraced by the Transylvanian Alps and the north-westerly sweep of the Carpathians, and is shut in to the west by a lofty granite mass called the Bihar Mountains.

The Carpathians form a regular series of ridges and valleys, consisting largely of sandstone and non-crystalline schists. The loftier and more irregular masses of the High Tatra and the Hungarian Ore Mountains which continue the Carpathians westwards are built of much older rocks, chiefly granite and crystalline schists. The upper Dniester and the Prut drain the hilly country which forms the Carpathian Foreland, their courses being roughly parallel to the folds of the mountain chain.

Between the western extremities of the Carpathians and the north-eastern extremities of the Alps lies the Vienna basin. This depression communicates with the northern plains by the Moravian Gate between the Sudetes and Carpathians, with Bohemia over the low Moravian heights, with south Germany by the Danube valley, and with the Mediterranean by the Semmering Pass. It is shut off by the Little Carpathian Range from the Upper Hungarian Plain, to which again the Danube gives access. On the level Upper Hungarian Plain the river splits up into a number of channels, which unite again as it passes through a gap in the hill ranges (the Bakony Forest and spurs of the Ore Mountains) which shut off the Lower Hungarian Plain.

This vast level tract, over which the Danube and its tributary the Theiss take very meandering courses, is the bottom of an ancient lake or inland sea, of which Lake Balaton is a remnant. The Sava flowing from west to east marks the boundary between the plain and the mountainous Balkan Peninsula. Deposits of loess, black earth, and alluvium form a rich soil over almost the whole plain.

The line of the south European fold-mountains can be traced from the eastern extremity of the Balkan chain, through the mountains of the south-east Crimea to the Caucasus Mountains, a range somewhat similar to the Pyrenees. Thus the deep basin of the Black Sea appears to be a sunken block embraced by folded chains, similar to the western Mediterranean, the plain of

the Po and the plain of Hungary. The Caucasus form a lofty range with a central belt of old crystalline rocks flanked by later sediments. A series of fractures to the south, followed by subsidence, accounts for the deep depressed valley in which flow the rivers Rion and Kur. The chief cross-route is that following the Terek valley to the Dariel Pass. The Caucasus are a link between the fold-mountains of Europe and those of northern Persia and Central Asia, and their height is greater than that of the former though less than that of the latter, for Elbruz rises to over 18.000 feet.

MINERALS

The best coal, and the greatest number of metallic ores, are found associated with the old (Palaeozoic) rocks. Hence outcrops usually occur in connexion with the regions of uplifted and dissected blocks of such formations, and in parts of the more recent mountains where rocks of former ages have been brought to the surface by folding and erosion. Among important exceptions are iron ores, which are widely distributed, and salt and lignite which may belong to the rocks of more recent formation. During the desert conditions which in distant geological ages prevailed in Europe, inland drainage areas and salt lakes were formed, such as are now found in arid regions; these gave rise to deposits of common salt and other salts. The disappearance or partial disappearance of inland lakes and seas of still more recent times has also given rise to beds of salt, as in the northern part of the Caspian depression. The impure brown coal known as lignite was formed in swamps and on sea margins at some time during the Cainozoic Period.

The chief coal mines lie along a line stretching from South Wales to South Russia, on the borders of the central uplands of Europe. To the north of the Rhine Massif the deposits, which are sometimes at a great depth, follow the line of the Sambre-Meuse valley, stretching from the district south of Lille to Aix (or Aachen); on the opposite side of the Rhine they lie along the valley of the Ruhr. To the south of the Massif there are coal-measures in the basin of the Saar, which is a tributary of the Mosel. Farther eastward, there are coal-measures to the north

of the block forming the Erz Gebirge, and to the south of this block on the Bohemian plateau; these are the Saxony and Bohemian coalfields. The Lower Silesian coalfield lies on the northern borders of the Sudetes, the upper Silesian coalfield is part of the small block of Palæozoic rocks which forms the hilly country between the Oder and the Vistula. In the worn-down block of old rocks lying in the Donetz valley there are coal-measures, and also near the source of the Don and on the eastern flank of the Ural Mountains. Turning to western Europe, there are coalfields on the Central Plateau of France, near its eastern border, and in the Cantabrian Mountains in the north of the Iberian plateau.

Lignite is found along the southern margin of the North German plain and on the eastern borders of the Alps.

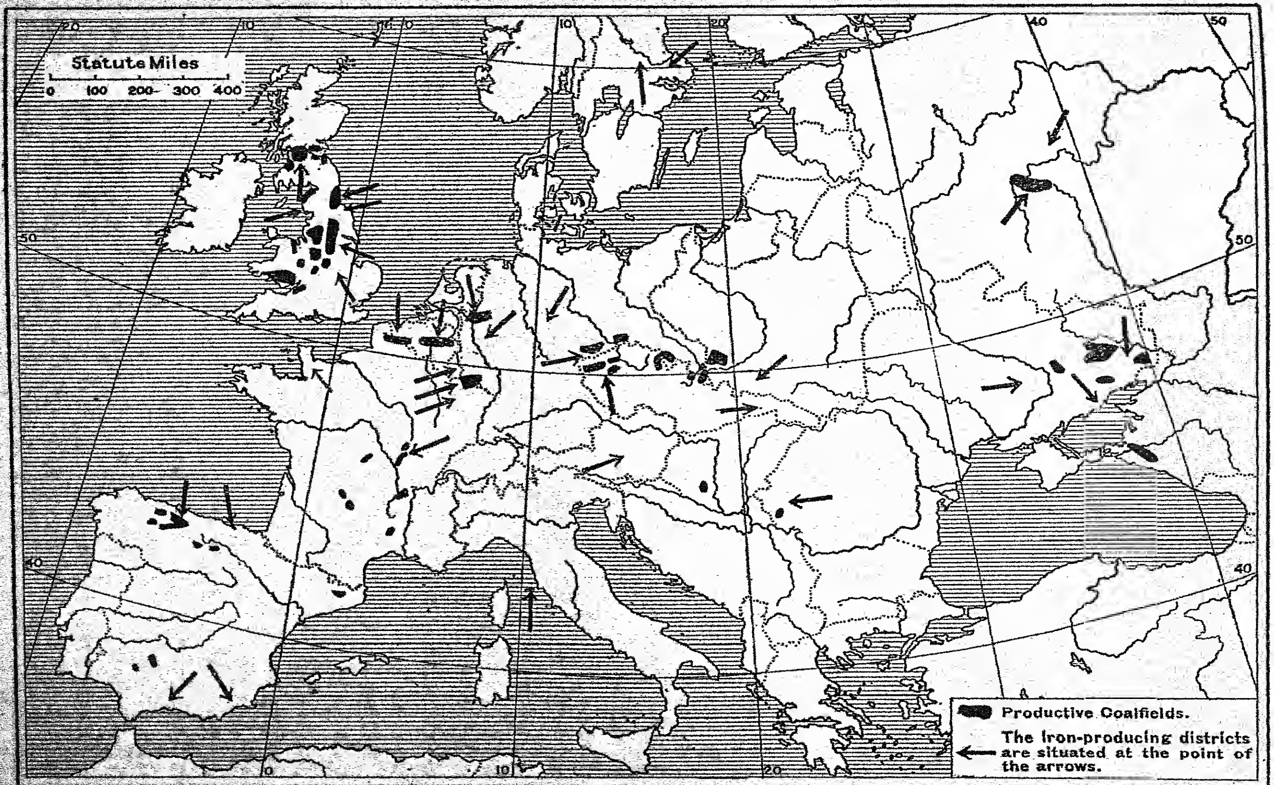
Petroleum, which is similar to coal both in its origin and in its economic value, occurs along the Carpathian Foreland, on the flanks of the Caucasus Mountains, and in Albania.

Salt is also very abundant in the western part of the Carpathian Foreland, while there are valuable deposits of potassic salts near the Harz Mountains, in the Rhine rift-valley (Alsace), and in the North Urals. Phosphates (for fertilisers) are mined in the Kola Peninsula (Russia).

There are zinc mines of importance in the region between the Sudetes Mountains and the Western Carpathians, but on the whole Europe is deficient in metallic ores other than those of iron. The chief copper mines are those of Spain, Norway, the Urals, and Yugoslavia, the chief tin mines those of Cornwall, while small quantities of silver, lead, zinc and copper are mined in several parts of the old worn blocks which form the uplands of Central Europe, e.g. in the Harz Mountains, in the Hungarian Ore Mountains, and in the Balkan Peninsula. Bauxite, from which aluminium is prepared, is obtained from the Alpine margin in France, from the Apennines, from the Dinaric Alps, and from the Kola Peninsula.

The chief sources of iron ore are shown on the map opposite, but to these must be added those of northern Norway and Sweden and those of the south of the Ural Mountains in Russia (Magnitogorsk).

For authorities and books for further reading, see end of Chapter XXIII.



GEORGE PHILIP & SON L^TD

Fig. 123.—Regions producing Coal and Iron Ore.

CHAPTER XXI

EUROPE—PHYSICAL CONDITIONS
(continued)

CLIMATE

Europe lies almost wholly within the belt of the stormy westerlies, and is thus under the influence of the procession of cyclones and anti-cyclones which cross the Atlantic, and of the changing weather conditions which accompany them. Europe may be compared with the western parts of the two Americas lying in the same latitudes, but two facts give the former region an advantage : the large inland seas prolong maritime influences eastward, and the general trend of the lines of relief from east to west offers no barrier to the Atlantic winds whereas in the Americas the great north-south cordillera limit oceanic influences to a narrow coastal belt. Moreover, the east-west mountain ranges of Europe shelter the southern countries from cold north winds which in America sweep down the central plains unchecked.

Winter Conditions.—*Pressure.*—European climate is controlled by three important pressure systems (see Fig. 71) : the Icelandic " Low," the Azores " High," and the continental system of Eurasia, which is a " High " or " Low " according to the season.

In winter the mean conditions show the Icelandic " Low " as a long trough stretching from the Atlantic into the Norway Sea. The gradients around it are very steep, and (in accordance with Buys Ballot's law) strong south-westerly winds prevail over western and north-western Europe. The Azores " High " is only weakly developed, but extends over Spain and joins the Eurasian " High " which sends out a tongue over Russia and

Central Europe. These high pressure areas are usually calm, with light outward-blowing winds. Cyclones pass very frequently along the borders of the Icelandic trough, and less frequently over the area of intermediate pressure to the north of the continental " High " or into the Mediterranean basin, which has a relatively low pressure.

Temperature.—The conflicting influences of oceanic winds and

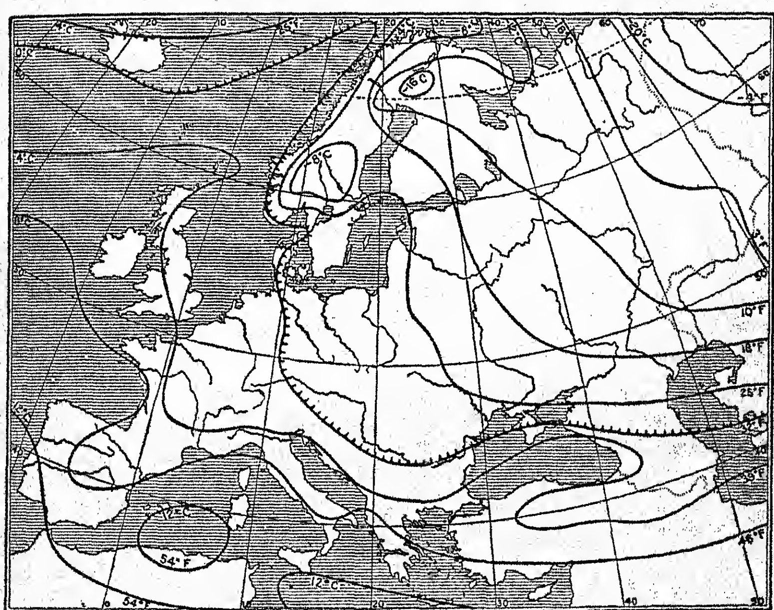


FIG. 124.—Europe. Mean January Temperatures. (After Hann.)

latitude determine the trend of the isotherms (see Fig. 124). According to latitude they should lie parallel to one another with a general west to east direction. But the Atlantic Ocean in winter has a high surface temperature, due not only to its retention of summer heat, but also to the warm drift which extends right into the Arctic Seas (see Fig. 78). Hence the winds blowing off this body of water are uniformly warm, and so tend to make the isotherms run parallel to the coast, i.e. in a general north-south direction. The map shows how oceanic influences

dominate the temperatures of the western margins, so that they are above or but little below 0° C. In the continental area the influence of latitude is sufficient to produce diagonal isotherms, running from north-west to south-east so that the extreme north-east of Russia, which is both remote from the sea (the Arctic being frozen) and in high latitudes, has the most intense cold, the temperature falling below −20° C.

In the Mediterranean area the warm sea has itself a west to east direction, and the general trend of the isotherms is similar, with slight bends as the warmer water alternates with the cooler land. Here the temperatures are all over 0° C. The hottest part of the continent is found where latitude and the nearness to the ocean alike favour a high temperature, namely in south-west Portugal (over 12° C.).

Rainfall.—On the cold continental area the capacity of the air for moisture is very small, and the precipitation, which occurs chiefly as snow, is also small (see Fig. 78). Only on the immediate ocean margins, e.g. in Scandinavia, the British Isles, western France and western Spain, is the rainfall abundant. The lands bordering the shallower North and Baltic Seas have their autumn rains prolonged into December, but in January and February these seas exert hardly any warming influence and the neighbouring lands are cold and dry. In the mild Mediterranean lands, the cyclones have their normal accompaniment of rain. On the lofty Alps there is a heavy snowfall.

Summer Conditions.—*Pressure.*—The pressure conditions for July (see Fig. 72) show the Icelandic " Low " less developed than in winter, while the Azores " High " is very marked, and has a more northerly position. Over the continental area the pressure is relatively low, the great Asian " Low " extending towards south-eastern Russia. The general wind direction is more nearly westerly than in winter, and cyclones pass across the continent. The belt in which they are found has shifted northward, so that the Mediterranean region now lies outside their influence.

Temperature.—Again the influence of the ocean winds, which are now relatively cool, competes with that of latitude in determining the trend of the isotherms (see Fig. 125). Thus in the western region these lines bend sharply northwards on passing

from the cooler ocean to the hotter land, while over the continental area they run from west-south-west to east-north-east as the temperatures rise with increasing distance from the sea. It may be noticed that across Europe, as over the British Isles, the isotherms are more nearly parallel to the lines of latitude in summer than in winter, showing that oceanic influences are less important at this season. In the north-western area the

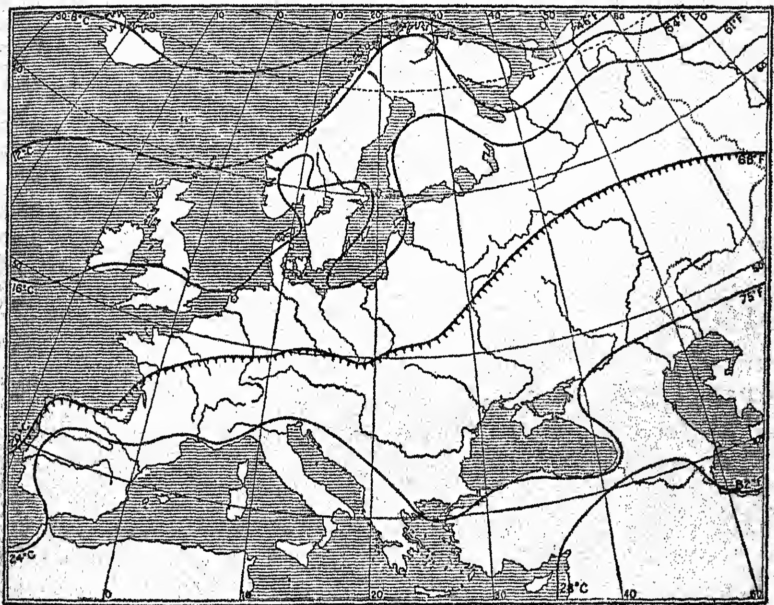


FIG. 125.—Europe. Mean July Temperatures. (After Hann.)

temperatures lie between 8° and 20° C., while in the Mediterranean region they are over 24° C. Similarly in the continental area a southern hot region over 20° C. may be distinguished from a cooler northern region with temperatures diminishing from 20° to 8° C.

Rainfall.—With the exception of the Mediterranean region which now lies south of the cyclone belt, the whole of the continent has rain during the summer (see Fig. 79). These are largely cyclonic and relief rains, but may also be associated with

local convection currents due to unequal heating, especially in the regions where high temperatures are found. The very high temperatures and the low relief of south-eastern Russia cause, however, a low rainfall there, for the capacity for vapour of the air is so great that the dew-point is not often reached; the maximum occurs in the earlier and cooler part of the summer.

General Conditions.—The range of temperature is least on the western margins, the difference between the January and July temperatures at Valentia (west Ireland) being only 8° C. Over the western and Mediterranean regions in general it is nearly everywhere less than 20° C., while in the eastern parts of the continental areas it is over 30° C.

The annual rainfall map (Fig. 126) shows a close connexion between the total precipitation and relief. On all the higher lands it is over 30 inches. The contrasts between the west and east of the Scandinavian Peninsula, the British Isles, Spain and the Balkan Peninsula respectively, show clearly the influence of the prevailing westerly winds. On the loftier mountain ranges, the Pyrenees, Alps and Western Caucasus, the precipitation is generally over 40 inches, and in places over 80 inches. The effect of a sheltering girdle of higher land is shown in the dry Iberian plateau, and the relatively dry Hungarian Plain.

As regards sunshine, the Mediterranean region is the most favoured, having over 2,500 hours a year as against less than 1,500 hours in the north-western peninsulas and islands.

In comparing temperature conditions it must be remembered that the isotherms give a correct picture only for the lowlands. To obtain an idea of the actual conditions it is convenient to separate off the land above 3,000 feet, and to assign to it a temperature about 5° C. below that of the surrounding district.

Climate Regions.—Putting all the climatic features together six climate regions may be distinguished.

1. The cold desert bordering the Arctic Ocean has a low precipitation, a long dark cold winter, and a very short cool summer.

2. The western marginal lands bordering the Atlantic Ocean have generally an abundant rainfall, well distributed through the year, but with a winter or autumn maximum. The summers

FIG. 126.—Europe. Mean Annual Rainfall.

are cool, the winters mild, the temperature range is moderate and the sunshine below the average.

3. The sub-continental or transition area shows a gradual change from the characteristics of the second to those of the fourth region.

4. The continental area has rain mainly in the summer, often somewhat deficient in amount, and great temperature extremes. It may be sub-divided into a northern region with very cold winters and warm summers and a southern region with very hot summers and cold winters. The latter has much less rain than the former.

5. The Mediterranean area is characterized by a summer drought. The summers are hot, the winters warm or mild, the temperature range is moderate, and the sunshine above the average. Here the cold mistral and bora and the oppressive sirocco blow.

6. The mountain regions, notably the Alps, have a heavy snowfall in winter, and some rainfall in summer. Although the air temperatures are low the insolation is very powerful, and the soil, especially on south-facing slopes, often gets very hot. The great daily range of soil temperature and the frequent frosts account for the enormous rock disintegration, which gives to the Alpine summits their sharp, ragged edges and peaks. The question of exposure is a very important one. Valleys opening southward receive the greatest insolation and are consequently unusually warm. Valleys with a general north-south direction are relatively dry, as they are protected from the rain-bearing winds. The height of the snow line is variable, since it depends upon the exposure, and the amount of precipitation. In the Alps and Pyrenees it lies between 8,000 and 10,000 feet. In the dry eastern Caucasus it lies at 11,500 feet on the cooler northern, and 13,000 feet on the sunny southern slopes.

THE RÉGIME OF THE EUROPEAN RIVERS

The changes in the volume of water brought down by the rivers, and the time of occurrence of high and low water respectively, depend to a very great extent upon the climate. Hence

the rivers of each of the great climatic regions have their special characteristics.

In the western marginal lands and in the western parts of the transition area, the rainfall is fairly uniformly distributed through the year. The amount that finds its way to the rivers is, however, lessened in summer and autumn, when there is a great loss by evaporation, and when the vegetation also makes use of a large quantity of water. In consequence, the floods occur in winter and spring, and low water occurs in summer and autumn.

In the continental region the cold winters and the summer rains determine the régime of the rivers. In winter they are frozen over, and the ground too is frozen and covered with snow, hence the run-off of water is small. In spring the break up of the ice and the melting of the snow cause sudden floods. The summer rains then keep up the water supply, but as this season goes on the great heat and evaporation make themselves felt, so that a maximum occurs in autumn.

In the Mediterranean region a shrinkage of volume is caused by the summer drought, so that a strong rushing winter torrent may be transformed into a tiny trickling stream. The rivers rising in mountain regions have also a very special régime. Two types may be distinguished—those which are fed by glaciers and perennial snowfields, and those which take their rise in mountains covered with snow in winter only. In the former case, the rivers are highest in summer when the melting of the snow and ice is greatest. In the latter case, the whole of the snows are melted by the end of spring, and hence this is the season of high water.

Some of the larger central European rivers have a more complex régime. The Danube takes its rise in the Black Forest, and its head streams are of the western margin type, low in summer. But it soon receives three important tributaries, the Inn, the Salzach, and the Enns, which being fed from the snow-fields and glaciers of the High Alps are highest in summer. Hence at Vienna the Danube shows a marked summer maximum. As it crosses the great Hungarian Plain the great evaporation causes a diminution of the waters in summer which is experienced also

by the Theiss and consequently at the Iron Gate it has a summer and autumn minimum.

The upper Rhine, which receives the waters of the Reuss and Aar, is an Alpine river fed by glaciers and permanent snowfields; it therefore shows a summer maximum at Basel. Its tributaries the Neckar and Main, and to a still greater extent the Mosel, show the western margin characteristic, namely a winter and spring maximum. Hence the lower Rhine combining the two régimes is remarkably uniform in its flow throughout the year.

The Rhone, itself a glacier-fed stream, receives the Saône, which is of the western margin type, and later the Isère and Durance, which are Alpine streams. Thus this river also is uniformly supplied with water through the year.

VEGETATION

A glance at the map (Fig. 95) shows that, with the exception of the hot desert, all the formations common to the temperate zone are met with in Europe.

Tundra.—The tundra, found in what has been described climatically as the cold desert region, occupies a narrow belt along the northern margin of Russia. With it may be included the treeless fjeld of the Scandinavian plateau, and the barren Ural summits where the same temperature conditions prevail.

Coniferous Forest.—The coniferous forest (consisting largely of pine, fir, larch and birch trees) stretches across Scandinavia and northern Russia, in a region where the winters are very cold and the rainfall is somewhat scanty. In the Swedish and Finnish parts of this forest, the fir is the predominating tree. Dwarf willows, bog myrtle, and low hardy berry-bearing bushes, of which the bilberry is the type, mark the transition from the cold forest to the tundra and fjeld.

Broad-Leaved Forest.—This forest, now largely destroyed by man, once covered almost the whole of western and central Europe. A narrow tongue stretches almost to the Urals. It occupies a region where neither the winters nor the summers are extreme and where the rainfall is over 20 inches. Among the trees are the oak, elm, beech, ash and poplar, and towards the

south the Spanish chestnut. On the dry sandy and gravelly stretches of the plains bordering the North Sea and the Baltic, wide heaths and pine forests take the place of these deciduous forests. Everywhere rich meadows are found which are largely artificial; mowing and grazing greatly improve the quality of the grasses. The uplands of this region, such as the Vosges, Black Forest and Erz Gebirge, are clothed with forests of sombre pine and fir.

Evergreen Trees and Shrub.—The evergreen trees and shrub region extends all round the borders of the Mediterranean, and far up the southward opening valleys of the Rhone and the Alpine rivers. Here there are mild or warm winters, sunny skies, a warm sea, and a protecting barrier of mountains which shuts off northern and continental influences. All the characteristic trees and shrubs, the cypress, holly, myrtle and laurel, have the same dark leaf-tints. Plants introduced from more tropical and more arid climatic regions, such as palms and cactuses find here a congenial home. Aromatic bushes and herbs, flowering plants with underground food stores, and heaths, largely take the place of grasses, except in the more favoured valleys and basins where meadowlands appear. On the dry Iberian plateau trees are absent, and the stretches of bush and alfa grass have almost a semi-desert aspect. The mountains are clothed with forests; in the Iberian Peninsula the cork oak, in Italy the chestnut, in the Balkan Peninsula the oak, beech and plane-tree are important. Only on the loftiest ridges, where the temperatures are very low in winter, do the coniferous forests of higher latitudes appear.

Steppe.—The steppe or grassland covers the south of the continental area, where the summers are hot and the rainfall somewhat scanty. It extends over the lower plain of the Danube, and a detached area appears on the Hungarian Plain. The boundary between the morainic region of northern Europe and the loess, which lies to the south, roughly coincides with the boundary between the forest and the treeless steppe, and must help to determine it. But it is probable that where climatic and soil conditions made tree growth poor and thin, the demand for timber on the part of the population was the actual cause of

its complete destruction. A noticeable feature of the steppe is the number of bulbous plants, such as tulips, hyacinths, crocuses and irises, which blossom brilliantly in spring and early summer, when all the herbs and grasses are still fresh and green.

Semi-desert.—A semi-desert is found round the northern shores of the Caspian Sea. Here the rainfall is very low and the soil is heavily charged with salt and alkali, left by the sea as it gradually shrank. Hence coarse herbs and scattered bushes form the main vegetation, and many spots are quite bare. Vast reed swamps are also a characteristic feature.

Mountain Vegetation.—A mountain vegetation is well developed in the Alps where the walnut and chestnut trees of the valleys are followed by deciduous forests, largely of beech and maple, then at higher levels come forests of pine, larch and fir, and still higher a belt of dwarf pines, heaths, whortle-berries and other small shrubs. At this level also the natural pastures occur, their luxuriant grasses studded with brightly coloured flowers. The meadows continue up to the snow line, except where the soil is too thin or the slopes too steep; in such places the rocks are bare or clothed with grey and yellow lichens. The same succession of belts is found on the Caucasus, Pyrenees, Carpathian and Balkan Mountains wherever the range of altitudes is sufficient, although the characteristic trees, shrubs, and flowers vary somewhat.

ANIMALS

The wild animals of Europe are mainly restricted to the forested uplands and mountains of the centre and south, and to the vast forests of Northern Russia, in all of which wolves, bears, wild cats and wild boars are found. In the cold forest the sable, ermine, and other valuable furred animals are trapped. The reindeer is the largest animal of the tundra; its spreading hoofs seem adapted to travel over the boggy surface, and the mosses and lichens afford it sufficient pasture. On the steppes there are still a few wild grazing animals such as the saiga antelope, and burrowing rodents such as the marmot. Another species of marmot is found in the high Alpine pastures. The agile chamois, ibex and wild sheep are characteristic of the loftier

mountain regions. The land connexion between Spain and Africa has only been broken at a recent geological period so that some of the animals of the two regions are similar, for instance the chameleon and the cat-like genet; the Rock of Gibraltar is the only place in Europe where monkeys are found.

NATURAL REGIONS

In dividing Europe into natural regions the great climatic and vegetation divisions are the chief guides, and in addition, the important distinction between plains and uplands or mountains must be made. Plains are usually, although not invariably, associated with a sea-board, and where a vast plain drains to more than one sea, it may be conveniently divided according to drainage areas, which form a natural physical unit. This last division must, however, always be subordinated to that according to relief, climate and vegetation.

The Regions of Europe are shown in the map Fig. 127. Full lines indicate the regions, dotted lines show political boundaries. Regions grouped under the same letter have important characteristics in common. The boundaries of certain of the plant formations were taken directly from the vegetation map. This gave four regions; (1) the tundra and fjeld; (2) the steppe; (3) the semi-desert; (4) the evergreen trees and shrubs of the Mediterranean Region. Thus the coniferous and broad-leaved forests were not differentiated. The next step was to separate the uplands and mountains of Central Europe from the bordering and enclosed plains. The plains themselves were then divided climatically, the western margins, the transition region and the continental regions being separated. But since these climatic changes are necessarily very gradual, the boundaries between the regions were drawn so as roughly to follow the river divides, thus separating the drainage area of the North Sea from that of the Baltic Sea, and the drainage area of the Baltic Sea from that of the Arctic and Black Seas. The Baltic plains then formed the transition area between the western marginal lands and the true continental regions.

A transition region between the tundra and the western margins was marked off at Trondhjem Fjord. This point was

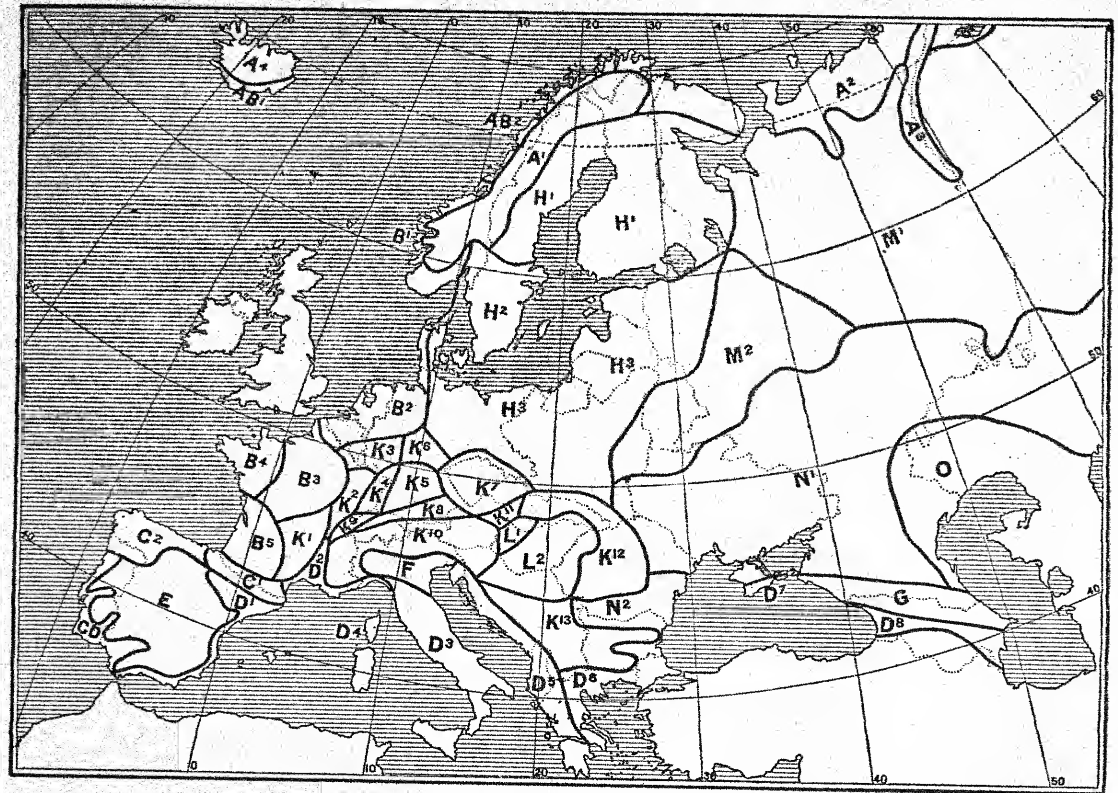


FIG. 127.—Europe. Natural Regions.

selected because here the small insolation characteristic of high latitudes makes itself practically felt. The air is still mild, owing to the Atlantic winds, but the summers are so short and the sun's rays so oblique that there is not sufficient warm sunshine to ripen the fruits of deciduous trees.

These regions were further sub-divided according to relief and structure, and thus the following regions were obtained :—

A. Cold Deserts. A1. *The Scandinavian Fjeld*, a lofty plateau snow-covered through the long winter and in places throughout the year, has a scanty vegetation of mosses, lichens and dwarf bushes. Much of it is ill-drained and swampy. Rivers have cut into it deep ravines, in which woods and upland pastures occur. Some of these rivers drain to the fiords on the west, others through the marginal fringe of long, narrow lakes to the east. The rain and snowfall is about 20 inches, a foot of snow being reckoned as an inch of rain.

A2. *The Tundra* occupies the low boggy plains bordering the Arctic Ocean. The subsoil is frozen throughout the year, and only in the short warm summer does the melting snow set free the vegetation to pass through its brief life-cycle. The rain and snowfall amount to only about 10 inches, and the winter cold is intense.

A3. *The Northern Ural Mountains* are so cold that they are outside the limit of trees and are almost bare of vegetation.

A4. *Northern Iceland*, which lies at a considerable elevation, is covered with snowfields, glaciers and barren lava-wastes. The coastline is deeply indented by fiords.

AB. North-western Transition Regions. AB1. *Southern Iceland* has a milder climate, with over 40 inches of rain, and though almost treeless the valleys and coastal lowlands are covered with rich pastures. The neighbouring banks abound in fish, and the surrounding seas with whales. The Faroe Islands are very similar.

AB2. *The North-western Margins of Scandinavia* have a well-developed fiord coast and a bordering chain of islands; the coastal waters abound in cod and herring, and the swift rivers in salmon. Where the slopes are not too steep, pines are the characteristic vegetation, with pastures on the terraces and

valley floors. The climate is mild, the rainfall abundant all through the year, but the winters are long and dark.

B. Western Marginal Lowlands. B[1]. *The South-western Margins of Scandinavia* are, owing to the latitude, warmer than the last-named region, and the rains are more abundant ; hence deciduous trees appear as well as pines. The fiords, often rendered more picturesque by waterfalls, penetrate far inland ; the extent of the lowlands, which have generally to be cleared of forest, is very small, the largest proportion being in the south.

B[2]. *The North Sea Margins* have flat, wind-swept, dune-bordered coasts which shelter a land that is below or but little above sea-level. Scarcely any natural wood-land is found ; reclaimed marshes and alluvial plains alternate with the heaths, cotton-grass moors and peat bogs which cover the glacial sands and clays. The British Isles, which here form the actual Atlantic margin, rob the westerly winds of much of their moisture, and rain falls chiefly in summer and autumn.

B[3]. *The Paris Basin* presents a diversity of landscape, soil and vegetation, due to the successive outcrops of different rocks. Scarped ridges of chalk and limestone covered with sheep-pasture alternate with rich clay plains, dotted with clumps of woodland. The rainfall round Paris is comparatively low, but it rises towards the seaboard, and towards the east where the land is higher. Spring is the driest season.

B[4]. *The Western Peninsulas of France* comprise Brittany and part of Normandy. Owing to their shape and situation they show to a marked degree the characteristics of a western marginal climate : the rainfall is heavy and well distributed through the year, the summers are cool, the winters mild. The region is built of old rocks, of which the more resistant form hills or uplands. On these uplands the soil is poor, and they form desolate moorlands clothed with bracken, furze and heather. In the lowlands and valleys, however, a rich mixed soil has accumulated.

B[5]. *The Garonne Basin* is a wide monotonous low-lying plain, which, owing to its southerly position, has much hotter summers than the regions just described. The rainfall is heaviest on the shores of the Bay of Biscay, but here the sandy soil of the Landes

can only support a vegetation of pines, heaths, and grasses. At the foot of the Pyrenees, soils of glacial origin show that these mountains were once more extensively glaciated. Farther north, soils rich in lime are brought from the Causses region into the fertile lower valleys of the Lot and Tarn.

C. Western Marginal Highlands. C[1]. *The Pyrenees*, owing to their mountainous character, form a region apart. They are clothed with dense forests of oak and beech, and at higher altitudes with pines and mountain pastures, but many of the loftier peaks and summits are so steep as to be bare of vegetation. Numerous cascades break the courses of the rushing mountain torrents, some of which are fed from snowfields and small glaciers. The rainfall is abundant, but decreases towards the east.

C[2]. *North-western Spain* includes the highlands of Galicia and the Cantabrian Mountains which are rich in iron ore. Its damp mild climate resembles that of western France, and much of it is still covered with deciduous forests.

CD. South-western Transition Region. *The South-western Margins of the Iberian Plateau* include the lower valleys of the Tagus, Guadiana and Guadalquivir. Although lying on the Atlantic border they resemble rather the Mediterranean region than the western margins. The rainfall is moderate, the summers are hot and dry, the winters warm and rainy, and there is an abundance of bright sunshine. The vegetation of the lowlands is of the Mediterranean type, and the slopes of the highlands are clothed with forests of cork oak.

D. Mediterranean Regions. D[1]. *The Western Margin of the Mediterranean together with the Ebro Valley* differs from the region last named in that it has a low rainfall of less than 20 inches. The rivers descend rapidly from the plateau, and where their velocity is suddenly checked they have in some cases built a delta or alluvial plain, but elsewhere the land rises steeply to the interior, and the only considerable lowland is the middle part of the Ebro basin. In this region, as is the case throughout the Mediterranean regions, many bare stony patches, devoid of soil and vegetation, give a desolate aspect to the hillsides.

D[2]. *The North-western Margins of the Mediterranean with*

the Lower Rhone Valley have a rather more abundant rainfall than has eastern Spain, and have in addition the advantage of a southern aspect. The low lagoon-bordered coast of the Lion Gulf may be contrasted with the precipitous shores of the Gulf of Genoa, where the coast is parallel to the folds of the mountains; the western part of this latter coast forms the Riviera.

D^3. *The Peninsula of Italy with Sicily* is mainly an upland region. The folded mountains which form its backbone lie in parallel ridges which in some parts are covered with forests of chestnut and beech, in others with poor pasture, and in others are bare of vegetation. These mountains are bordered by low hills and by fertile plains of volcanic débris or river alluvium, but the latter are often marshy and unhealthy. On these borders the vegetation is typically Mediterranean, characterized by the olive, evergreen oak, cypress, and many low aromatic shrubs. The rainfall is everywhere plentiful, only in the south-east margins and in Sicily is it less than 30 inches, while in the northern Appennines it averages 40 to 60 inches. The summers are, however, dry and at this season only a tiny thread of water finds its way over the stony beds of the smaller rivers.

D^4. *Corsica and Sardinia* are two mountainous islands formed of granite and other ancient rocks. Except that the fold mountains are replaced by irregular masses carved out by erosion, their characteristics are those of southern Italy.

D^5. *The Western Slopes of the Balkan Peninsula* are characterized by their folded mountain chains and Dalmatian type of coast. The rainfall is everywhere heavy (40–80 inches), but the mountains of the northern region, where the trend-lines are from north-west to south-east, are formed of a porous soluble limestone, so that the surface appears arid and waterless; the drainage is mainly underground, and many dry valleys and basins are found, due to the subsidence of the surface above underground channels and caverns. The vegetation is very scanty, save where some voluminous stream gushes from the rocks and leads to the formation of a green oasis. Farther south, in the Pindus Mountains, where the limestone is harder and is sometimes transformed into marble, these features are less marked, and there are forests of chestnut, oak and plane, while near the summits pines appear.

Throughout the region the valleys and lowland margins are similar to those of Italy.

D[6]. *The Eastern Slopes of the Balkan Peninsula* are much drier than the western, the rainfall is less than 30 inches, and in places less than 20 inches ; thus the mountains have often a bare aspect. The relief is irregular, and the lowlands take the form of level-floored, alluvium-filled basins, encircled by steep hills, such as those of Attica and Thessaly, Adrianople and Philippopolis.

D[7]. *The Southern Crimea,* like the Riviera of the western Mediterranean, is a region where fold-mountains rise steeply from the sea, and the slopes have a southern aspect. The rainfall is sufficient, and rich groves of chestnut and walnut, together with the characteristic shrubs of the Mediterranean, form the vegetation.

D[8]. *The Kur and Rion Valleys,* running in opposite directions from a somewhat steep divide, are similar to the valleys of Greece and Italy.

E. The Iberian Plateau.—The Iberian plateau, or meseta, stands apart from the rest of the Mediterranean region as regards its structure, climate and vegetation. The rainfall is low and the air very dry, so that both insolation and radiation are rapid, and extremes of temperature, both daily and seasonal, are the result. The centre of the plateau has more hours of sunshine than any other part of Europe, but its level surface is often swept by piercing winds. In places the soil is poor and stony, and the vegetation of a semi-desert character, but in the basins of Old and New Castile more fertile cultivated districts are found.

F. The North Italian Plain.—The north Italian plain also is hardly Mediterranean in its characters, for its moderate rainfall is fairly uniformly distributed through the year, and owing to its situation the winters are bleak and such a characteristic Mediterranean tree as the olive is absent. The plain is floored with alluvium brought down by muddy torrents from the Alps, and the river Po has so raised its bed that it is only kept to its course by artificial means. It is used for irrigation, for in spite of the rainfall the great evaporation in summer gives to the country a parched appearance.

G. The Caucasus Mountains.—The Caucasus Mountains are very similar to the Pyrenees; they have a similar distribution of rainfall and the same zones of vegetation, but owing to their position in south-eastern Europe they have hotter summers and the snow line is about 2,000 feet higher.

H. The Baltic Lowlands.—H¹. *Northern Sweden and Finland* both form part of a peneplain of very ancient rocks. The region is clothed with forests of fir, and throughout its area deposits of sand, gravel and clay, trains of boulders or "erratic blocks," scratched and polished surfaces of bare rock, show that it was once covered by an ice-sheet. In Finland the ice-sheet has left innumerable irregularly shaped lakes and swamps. In Sweden the gently undulating plain rises gradually to the plateau to the west, and is crossed by parallel streams. The range of temperature is considerable, being over 20° C. (36° F.), and the rainfall, which occurs chiefly in July and August, is only moderate, averaging about 20 inches.

H². *Southern Sweden,* owing to its lower latitude and to the fact that it does not lie in the lee of the plateau, has a smaller temperature range and a rather heavier rainfall than Northern Sweden. The forests contain deciduous as well as coniferous trees, and the soils although mainly of glacial origin are in some places fertile, especially in the extreme south. The great lakes are an important feature.

H³. *The South Baltic Plains* have cold winters and rather hot summers, with a moderate rainfall occurring chiefly in summer. Their lakes and swamps, heaths and pine woods must be associated with the deposits left by the ice-sheet. The forests of beech and oak which once sprang from the more fertile soils have been largely destroyed, and these areas, with the fertile loess regions towards the south, are now under cultivation. Along the low lagoon-fringed shores the reclaimed marshlands recall those of the North Sea borders.

K. The Central Uplands and Highlands.—K¹. *The Central Plateau of France,* owing to its altitude and exposed situation, has cold, bleak winters. The rainfall is heaviest on the western margin, where the winds first meet the uplands, and on the Cevennes where the altitude is greatest, the central part being

somewhat drier. The great stretches of granite yield an infertile soil and the limestone Causses are very dry, so that much of the region is poor pasture land, but the soils of the volcanic regions and of the valleys are very rich.

K^2. *The Burgundy-Lorraine Region* consists of low plateaus of sandstone and limestone, crossed by the Upper Mosel and Meuse, and by the fertile alluvium-filled valley of the slow-flowing Saône.

K^3. *The Rhine Massif* is famous for its scenery, but except for the deeply-cut valleys, it forms a bleak and infertile region, partly covered with forest, bog, and moorland.

K^4. *The Rift Valley of the Rhine* is a rich level plain, covered with alluvium and with deposits of loess, over which the Rhine and its tributary the Ill meander. As it lies under the lee of the Vosges Mountains its rainfall is moderate; the winters are mild, the summers hot. The Vosges and Black Forest Mountains, rising steeply from its margins, have a heavier rainfall, in places over 60 inches. They are cut by deep, wooded ravines, and their lower slopes are clothed with beech and oak, while their rounded summits bear coniferous forests.

K^5. *The Uplands of the Main and Neckar Basins* take the form of scarped ridges. The chief formations are sandstone, which yields a poor soil, and limestone. The rivers flow in zigzag courses, now across and now parallel to the ridges, until finally they cut through the steep border of the rift valley of the Rhine.

K^6. *The Uplands of Thuringia and the Weser Basin* form a region of rounded hills intersected by winding valleys. The soils are fertile, and the lower hills, though dotted with clumps of oak, beech, and elm, are often cultivated to their summits, but the upstanding blocks of the Harz Mountains and Thuringian Forest Mountains are covered with heath and pine forests, and are intersected by deep ravines. The rainfall is everywhere abundant.

K^7. *The Bohemian Plateau* is bordered by highlands, so that its rainfall is rather low, in places less than 20 inches. Its temperatures are somewhat extreme, the range being slightly over 20° C. (36° F.). The surrounding highlands are well watered and clothed largely with coniferous forest.

K[8]. *The Alpine Foreland* is largely covered by infertile glacial deposits, which lead to the formation of lakes, swamps and moorlands. Fertile alluvium has, however, been deposited by the swift, muddy Alpine rivers which cross it to join the Rhine and Danube.

K[9]. *The Jura Mountains* are a series of long, flat-topped ridges, sometimes wooded, sometimes cultivated to their summits. They present steep, sunny slopes to the Alpine Foreland on the south-east. The rainfall is abundant, everywhere over 40 inches.

K[10]. *The Alps* show a great diversity of climate and vegetation, with changing altitude and aspect. Their summits might be included with the cold desert regions. The northern and interior valleys are similar to those of Central Europe, while the valleys opening southward, such as that of the Ticino, belong to the Mediterranean region.

K[11]. *The Vienna Basin* is the meeting-place of routes; it is a fertile plain surrounded by an amphitheatre of forested mountains.

K[12]. *The Carpathian Mountains*, with their long sweeping sandstone ridges and irregular masses of granite and crystalline schists, are covered with immense forests, beeches, oaks and poplars being followed at higher levels by various conifers; only a few of the highest summits lie above the level of trees and are covered with Alpine pastures.

K[13]. *The North Balkan Highlands* are intersected by deep valleys draining to the Danube. Outcrops of limestone, sandstone, granite, and mica-schist lend variety to the colours and outlines of the hills, and the mineral wealth is considerable. Large forests of oak and beech are found, and the broad summits of the Balkans are clothed with natural pastures. The rainfall averages only about 30 inches, most of the moisture brought by the winds being condensed by the Dinaric Alps lying to the west of this region.

L. The Hungarian Plains.—L[1]. *The Upper Plain* is fertile, well-wooded, and well-watered.

L[2]. *The Lower Plain* has only a moderate rainfall, occurring chiefly in summer when the great heat leads to a rapid evaporation. The low relief causes the formation of swamps near the

rivers, but there is an abundance of fertile soils, consisting of alluvium, loess, and black earth. The plain is nearly treeless, much of it (the pusstas) being natural grassland or steppe.

M. The Russian Forests.—M¹. *North-eastern Russia* is a plain almost covered with coniferous and birch forests. It has extremely cold winters, and a low rain and snowfall, generally less than 20 inches.

M². *Central Russia* has cold winters and hot summers, with a rainfall rather over 20 inches; it is still largely covered with forest, partly deciduous and partly coniferous. Much of the region lies above 600 feet, but the slopes are slight, and this fact, together with the abundance of glacial clays, leads to the formation of swamps. The greatest of these, the Pripet marsh, is now being drained and converted into meadow land.

N. The European Steppes.—N¹. *The South Russian Plain* is characterized by its low rainfall (under 20 inches), and its extremely hot summers. Here deposits of loess and black earth occur. The natural vegetation is steppe, and although large areas are under cultivation, equally large tracts of grassland still remain, especially in the hotter and drier south-east.

N². *The Lower Danubian Plain* is very similar in its soils, vegetation and general characters to the Lower Hungarian Plain, but the climate is drier and somewhat more extreme.

O. The Caspian Depression.—The Caspian depression, with its vegetation of poor steppe and scrub, its vast reed-swamps and brine-filled hollows, is at the same time the driest, hottest, and most desolate region in Europe.

For authorities and books for further reading, see end of Chapter XXIII.

CHAPTER XXII

EUROPE—POLITICAL AND ECONOMIC CONDITIONS

RACIAL MIGRATIONS AND SETTLEMENTS

It seems probable that after the Ice Age the first migrants into Europe were ancestors of the present Mediterranean Race, long-skulled and dark; that the Nordic Race evolved in the northern portion of the continent, becoming taller and fairer, and that the broad-skulled Alpine peoples made their way along the highlands and plateaus from Western Asia, advancing in two waves, the first, which was composed of the "Q-Kelts," reaching central and western Europe about the tenth century B.C., and the second, composed of the "P-Kelts," following them about five centuries later.

After this movement, the great Roman Empire was established in the Mediterranean region, stretching out as far as the Danube, the Rhine, and Britain, and so including within its dominion peoples of all three races.

In the first few centuries of the Christian era there were three great movements of peoples: (1) The Slavs, who were of the Alpine Race, grew greatly in numbers and spread out widely over the east of Europe; from these the bulk of the Russians of to-day are descended. (2) The Germanic peoples, who were of the Nordic Race, migrated westwards and southwards, e.g. the Jutes, Angles and Saxons settled in Britain, the Franks established themselves in Gaul (France), the Vandals penetrated into Spain and thence crossed into North Africa, and the Goths and Lombards invaded Italy. These migrations seem to have been caused by pressure upon the Germanic tribes from the east, due partly to the spread of the Slavs and partly to the third great racial

movement. (3) The dreaded Huns, horsemen of Mongolian Race, pressed in from Asia across the steppe-lands, and in the fifth century almost overwhelmed Europe. It was to protect themselves from these Huns that the Veneti founded the city of Venice upon the islands of the Adriatic.

These incursions were an important factor in the break-up of the Roman Empire. In A.D. 395 the Empire was divided into two portions; that in the east long remained with its centre at Constantinople, but that in the west soon fell before the Goths. In the succeeding period a number of states were formed, differing in size and importance, and among these the greatest was that of Charlemagne which later, and after some modifications, became known as the "Holy Roman Empire," and from this the present German State has evolved.

Meanwhile Arabs, led at first by Mahomet, established a great empire in south-western Asia and northern Africa; thence, under the name Moors, they crossed where the fold-mountain system almost unites Africa with Spain, overran the Iberian peninsula and menaced Europe. They were beaten back at Tours in France in A.D. 732.

Somewhat later Asiatic Avars and Magyars from the steppes penetrated into central Europe, the latter settling permanently in the steppes of Hungary and becoming largely Europeanized.

At about the same time there was another movement of Northern peoples in the Scandinavian invasions of Britain, the Norman (Northman) invasion of the Frankish Empire (hence Normandy), and their incursion even into the Mediterranean regions.

In the thirteenth century Turki tribes, known as "Tatars" or "Mongols," overran nearly all Asia and eastern Europe, even until about A.D. 1500 dominating the Russian Slavs, while the Ottoman or Osmanli Turks after having established themselves in the plateau of Asia Minor, took Constantinople in A.D. 1453 and threatened a Mahometan conquest of Europe; their advance, however, was checked by the Magyars, and the Turkish Empire was bounded by the river Save.

Finally, the Asiatic and Mahometan dominance in Europe disappeared, owing to the gradual conquest and the expulsion of

the Moors from Spain and to the growth of the Slavonic empire of Russia, which conquered and absorbed the Asiatic elements of the eastern part of the continent; only in the Balkan peninsula is there now a Mahometan power, and the last three centuries have seen the Turkish territory in Europe reduced almost to extinction.

FRANCE

Natural Regions.[1] *Western Marginal Lowlands:* Part of North Sea Margin (B^2); Paris Basin (B^3); Western Peninsulas (B^4); Garonne Basin (B^5). *Western Marginal Highlands:* Northern Slopes of the Pyrenees (C^1). *Central Uplands and Highlands:* Central Plateau (K^1); Burgundy-Lorraine Region (K^2); western portion of the Rift Valley (K^4); western portions of Jura Mountains (K^9); south-western portions of the Alps (K^{10}). *Mediterranean Regions:* North-western margin of the Mediterranean Sea and the Lower Rhone valley (D^2); Corsica (D^4).

Historical and Political Survey.—The people of the Paris and Garonne Basins are almost entirely of the Northern Race, but in the Western Peninsulas and in the Central Plateau the influence of the Alpine Race is apparent, and that of the Mediterranean Race in the south-east of the country.

The Roman Conquest of Gaul led to the adoption of the Latin language, from which French is derived. The Franks occupied the Île de France, which is at the same time the centre of the Paris Basin and the nucleus from which modern France has grown. Their king, Clovis, after having destroyed the Roman authority, chose as his capital an island on the Seine. The island, now the Île de la Cité in the heart of Paris, made the river easily bridged at this point, and towards it several of the tributaries of the Seine converge.

The successive rulers of Paris, notwithstanding occasional

[1] A political map showing the extent and boundaries of each country should be carefully compared with the physical maps of relief and climate, in order that the essential characteristics of the country may be realized. To aid this study, a list of the natural regions which are comprised in the political area is placed at the head of the section dealing with each country.

reverses, gradually gained power over the more outlying portions of modern France, and their capital city still forms a convenient seat of government, since it is well placed in the fertile and populous plain and is a centre of routes diverging to all parts. Thus to the north-west are Normandy and the English Channel reached by the Seine itself; to the west is Brittany; to the south-west the passage is easy to the Loire and thence to Anjou and Poitou and, through the Gate of Poitou, to Guienne and Gascony in the Garonne Basin; to the south-east, roads lead by the valleys of the Yonne and the Upper Seine to Burgundy and the Mediterranean provinces Languedoc and Provence; to the east, reached by the Marne valley, are Champagne and Lorraine; to the north-east the Oise leads to Picardy and Artois. These regions, the more important of the old provinces which were incorporated into the kingdom of France, remained as administrative divisions until the French Revolution, when the modern departments, now ninety in number, were organized.

The Franco-German war of 1870 led to the loss of the province of Alsace and part of that of Lorraine, and the boundary was withdrawn from the Rhine. The defeat led also to the establishment of the present French Republic. The former boundary was restored by the Peace Treaty of 1919.

The population of France is about 42,000,000 persons, i.e. much less than that of the British Isles, although the area is rather more than one and three-quarter times that of the British Isles. Paris has grown so greatly as a centre both of government and trade that its population, with the suburbs, numbers nearly 3,000,000; thus it is one of the greatest cities of the world.

Agriculture.—Half the total area of France is under cultivation, and of the remaining half, one-third is grassland, and another third bears forests. Therefore a much greater proportion of the land produces crops than is the case in the British Isles, partly because the higher summer temperatures allow cultivation to be carried to a greater altitude in the uplands, and partly because of the thorough cultivation due to the system of "peasant proprietorship," by which a considerable proportion of the land is owned by small landowners who work their own farms.

The greatest area is devoted to wheat-growing, and in France

there is eight times as much land under wheat as in the British Islands. In the production of this cereal France ranks fifth among the countries of the world, being surpassed by the United States, Russia, India and Canada, but these countries have, of course, a far greater extent of available land. In all the northern part of France with the exception of the Western Peninsulas, there is a great deal of wheat-land, but the greatest production is in the Paris Basin, where the summer rainfall and temperature do not greatly differ from those in the wheat-growing districts of the east of England. Oats are another important crop of the Paris Basin.

The Western Peninsulas, with rather more rain and poorer soils, are comparable with the west of England. They are pastoral rather than corn-growing districts, and butter is largely made and exported even to London. The market gardens and orchards supply vegetables and fruit to Paris and the other towns of northern France, and also to England.

The vine is the most valuable of the agricultural products, and France is the greatest wine-producing country in the world. Here, as usual, the vine is grown in the river valleys, largely on slopes facing sunward. The chief regions are the valleys of the Garonne and Dordogne, claret being obtained from the district north of Bordeaux, a great collecting and exporting city; the valleys of the Allier and the Loire; the region of the head-streams of the Seine system, where the wine takes its name from the province, Champagne; the Saône valley, where the eastern slope of the Côte d'Or produces Burgundy; the Rhone valley and the Mediterranean margins.

The sugar-beet is widely grown in the north-eastern half of the country and is very important in the provinces of Artois and Picardy. Flax and hemp are both grown in the Western Peninsulas and flax also in the region extending behind the coast from the mouth of the Seine eastward to Holland. Oils are obtained from the seed of the flax and hemp, and a great quantity of colza-oil is produced in the north-east. Oil is also obtained from the olive, which is cultivated in the whole of the Mediterranean region (D^2). The silkworm is reared on the leaves of the mulberry trees grown in most parts of the Rhone valley.

The district of the Riviera, where the terraced slopes of the

Alps overlook the Mediterranean Sea, produces oranges and other fruits. The centre of the coastal strip is Nice, the largest of a number of pleasure resorts renowned alike for their beauty and their warm winter climate.

Mining and Manufactures.—The mineral wealth of France is much less than that of Britain, and in consequence manufactures do not occupy so large a place in the life of the country.

The largest coalfield is in the north-east; it is the western end of the Belgian coalfield and extends south of Lille. This is the largest of a group of manufacturing towns; it makes linen, with the flax grown in the neighbourhood, woollen goods and cotton goods. Roubaix, close to Lille, and Rheims, situated among the sheep pastures of the chalk downs, manufacture much wool. Cotton goods are more largely made at Rouen, a port well placed on the Seine for obtaining American cotton.

Smaller coalfields are distributed on and around the Central Plateau, notably near St. Etienne, where silk ribbons and iron goods are manufactured. The coal from this field is taken to Lyon, the third city of France, and the most famous silk-weaving centre in Europe. It is also a great trade and traffic centre.

France has very large resources of iron ore in Lorraine, and at Nancy, on a tributary of the Moselle, and other centres a considerable iron and steel industry has developed.

A cotton industry has grown up on both sides of the Vosges using water-power as well as coal; Mulhouse, in the Rhine valley, is a large centre of cotton manufacturing.

Water-power at Lyon from the Rhone, and near St. Étienne from the Loire, is also used to supplement coal; while in the French Alps there are many hydro-electric installations for various industries. Here a new industrial region has arisen, e.g. near Grenoble there are large glove, steel and chemical works.

Paris, away from the supplies both of coal and of raw materials, but a favourite city for well-to-do people, makes articles of little bulk but considerable value such as gloves, millinery and jewellery.

Communications and Commerce.—The lowlands of the north of France have routes radiating in all directions from Paris. These reach the northern coasts at several points; Dunkirk, Calais, Boulogne and Dieppe are "ferry towns" with cross-

Channel trade; Le Havre and Rouen share the trade of the Seine estuary; Cherbourg is a calling place of American liners and the cross-Channel boats from Southampton; Nantes and St. Nazaire are the ports of the Loire valley.

The routes of Southern France lie around the Central Plateau. The chief of these is that served by the Paris, Lyon, and Mediterranean (P.-L.-M.) Railway, which runs up the Yonne valley and over the Côte d'Or to Dijon. From Dijon a route branches eastward to Germany through the Burgundian Gate, which is defended by the fortress of Belfort. The P.-L.-M. Railway proceeds from Dijon southwards along the Saône valley to Lyon, where it is joined by a route from the Upper Rhone valley and Switzerland. From Mâcon, north of Lyon, a route branches south-eastward to Italy through the Mont Cenis tunnel. Thus the Lower Rhone valley is one of the most important trade routes in the world, connecting as it does the great countries of north-western Europe with the Mediterranean region and beyond it the Eastern world. Hence arises the importance of Lyon at its northern end. Marseille, the second city of France, is not at the mouth of the Rhone, but at the eastern extremity of its delta, where its harbour is clear of the river-silt swept westward by the currents of the Mediterranean Sea. In addition to its great trade, Marseille has the industries of oil-refining and soap-making, aided by the neighbouring cultivation of the olive. South-east of Marseille is the well-sheltered harbour of Toulon, the great Mediterranean naval station corresponding to Brest on the Atlantic coast and Cherbourg on the English Channel.

In the restored provinces of Eastern France, Metz is at the crossing point of routes from south to north along the Moselle valley, and from west to east through Lorraine. Strasbourg, on the Ill, near its confluence with the Rhine, has a similar position in Alsace. Both have many manufactures.

West of the Central Plateau, the great route is from Paris south-westward, meeting the Loire at Orleans, following its course to Tours and then passing southward through the Gate of Poitou to Bordeaux. The road to Spain proceeds by way of the Landes and skirts the western end of the Pyrenees.

From Bordeaux the route to the Mediterranean region runs

up the Garonne valley as far as the turn of the river at Toulouse, whence the Gate of Carcassonne permits a passage between the Pyrenees and the Cevennes.

The rivers are largely used for inland navigation ; their usefulness is increased by a number of canals connecting them with one another and with those of the neighbouring countries. Thus the Oise is connected with the Meuse, the Sambre, and the Schelde ; farther south there is the Marne and Rhine Canal passing through Nancy and through the Pass of Saverne ; from the Saône valley several canals radiate, notably the Burgundy Canal to the Yonne, the Canal du Centre to the Loire, and the Rhone and Rhine Canal through the Burgundian Gate ; the Garonne and Rhone are joined by the Canal du Midi by way of Toulouse and Carcassonne.

The foreign commerce of France is carried on through the northern ports mentioned above, the Seine valley being the chief route to the Atlantic region ; through Marseille, which trades with southern Europe and the Orient ; and Bordeaux, towards which the traffic routes of the south-west converge.

France is exceptional among the countries of Europe in not importing any great amount of food ; coal and petroleum are imported, and raw materials such as cotton, wool, and silk. Exports, in addition to wine, consist mainly of textiles ; of these cotton and silk goods take the first place, woollen goods being of less importance. Chemicals and steel goods form a large item in recent years.

BELGIUM

Natural Regions.—*Western Marginal Lowlands :* The western corner of the North Sea Margin (B^2). *Central Uplands :* The western corner of the Rhine Massif (K^3).

Historical and Political Survey.—A line passing just south of Brussels across Belgium from east to west divides both the area and population into two approximately equal portions ; in the northern portion are the Flemings of the Northern Race, whose Flemish language is very similar to Dutch ; in the southern portion are the Walloons of the Alpine Race, speaking French. The whole of the country is Roman Catholic, and in this is in sharp contrast with Protestant Holland.

After a chequered history, in the last stage of which the

country was a portion of Napoleon's Empire, Belgium was joined to Holland for a short time, but the religious differences led to the establishment of a separate Kingdom of Belgium in 1830. Its position between France and Germany has led to its being a frequent battle-ground of greater states, Waterloo being for nearly a century the last of a long series of battles. Belgium, like Switzerland, had its independence and neutrality guaranteed by the greater powers of the Continent, but was invaded by Germany in 1914, and occupied for four years. The capital is Brussels, on an unnavigable tributary of the Schelde, with which, however, it is connected by one of the numerous canals of North Belgium.

The area of Belgium is very small, one-tenth that of the British Isles, but its resources are great and the population is therefore considerable, being about 8½ millions. Consequently the density of population is greater than that of any other country of Europe.

Agriculture.—The Kingdom may be divided into three parts: (1) In the north-west and immediately behind the dune-coast is a damp, dairy-farming area which would be swamped at high tide were it not for embankments and artificial drainage. (2) Between this belt and the Sambre-Meuse valley is a lowland, generally fertile except for the sandy and largely heathered-covered district of the Campine in the north-east. Beneath the Campine, however, a "concealed" coalfield is now being worked.

The greater part of the lowland region is a continuation of the north-eastern portion of the plain of France, and hence raises the crops mentioned in connexion with that district, namely, wheat, flax and the sugar-beet; but in Belgium a greater acreage is given to rye and to oats than to wheat. This predominance of these two hardier grains is a characteristic of the agriculture of all northern Europe, except France, and becomes more marked as one goes eastward.

(3) South of the Sambre-Meuse valley are the uplands, forming part of the Rhine Massif, which in the south-eastern corner of Belgium and in the small independent state of LUXEMBURG rise into the Ardennes, still wooded to a considerable extent; this region is not, however, important agriculturally save in the deeply-cut valleys of the Meuse and its tributaries.

Mining and Manufactures.—The production of coal is very great in relation to the size of Belgium. It is found on the borders of the uplands along a belt a little to the north of Mons, Namur and Liége, and under the Campine. The situation of these last two towns at the junction of routes is also significant: Namur being where the Meuse emerges from the uplands and bends eastward after receiving the waters of the Sambre, and Liege where it bends northwards after receiving tributaries from the south and east. Iron ore is found in the same belt as the coal and also south of the Ardennes, being brought from Luxemburg to Liége, which has a considerable industry in the making of iron and steel goods, besides chemicals. Woollens and other textiles and glass are also manufactured in this mineral region. More important, however, is the making of linen and cotton goods in the neighbourhood of the Schelde and the Lys, with its chief development at Ghent, where the two rivers meet.

Commerce.—The short, unbroken and sand-blocked coast of Belgium is unfavourable for trade, and the only large port is Antwerp, situated on the estuary of the Schelde, where it turns northward to enter the sea in Dutch territory. Ostend is merely a packet station. Thus Antwerp carries on most of the foreign trade of the country, and has in addition manufacturing industries of sugar and lace. Access to both Ghent and Antwerp has been greatly improved by the construction of artificial waterways connecting them with the Seine in the south-west, the sea to the north-west, the mineral region of Belgium in the south-east and the Rhine in the east. Iron goods and textiles are the leading exports, while wheat and raw materials for manufacture are imported.

HOLLAND

Natural Region.—*Western Marginal Lowlands*: The central portion of the North Sea Margin (B^2).

Historical and Political Survey.—The people of Holland belong to the Nordic Race; their language is Dutch, and in religion the greater part of the nation is Protestant.

Their history has been marked by love of liberty, both religious and political, shown most notably in the Eighty Years' War

against Spanish oppression, and paralleled by the constant struggle against the sea for dominion of the land.

The government is, like that of the British Isles, a limited monarchy; it has its seat in the comparatively small city The Hague. The country is slightly larger than Belgium, and the population is rather greater, being nearly 9 millions.

Agriculture.—Since a quarter of the land is below sea-level, the Dutch have had to build dykes and otherwise to protect the coast from encroachment both by the sea and the wind-blown sand, and to drain the areas thus gained by pumping the water into canals which run along embankments and serve also as means of communication. A large portion of the Zuider Zee is now reclaimed for farming, a dyke built across its entrance having shut out the sea.

Farther south much of the land has had to be similarly dealt with, as it is below the level of the courses of the Rhine and Maas. These reclaimed areas, termed polders, form valuable pasture lands for cattle, so giving rise to the making of butter and cheese. The cultivation of bulbs is a characteristic industry, largely centred around Haarlem. The growing of vegetables is widely spread, and is peculiarly important in the tract of land between the river Waal and the lower Rhine.

The higher lands include part of the poor Campine area in the south-east, and in the north-east also there are relatively barren stretches of moorland, but the remaining portions of these higher lands are extremely fertile, the products being almost exactly comparable to those of Belgium save that wheat is grown to a less extent.

Manufacture.—Holland has recently supplied her own needs of coal from a field in the extreme south; apart from this, its lack of minerals has caused it to take a lower place among the nations in regard to manufacture than before coal and iron became the chief basis of industry. Textiles are the chief productions, and in connexion with these Utrecht may be mentioned, while Delft has long been noted for the making of fine pottery.

Communications and Commerce.—The position of Holland at the mouths of the Rhine and Maas has led to a very considerable transit trade, and also to the growth of trade at Rotterdam.

Although this port is on the largest of the mouths of the Rhine, artificial waterways have had to be constructed for large ships. The largest city is Amsterdam at the south-western extremity of the Zuider Zee. Access by way of this sea proved inadequate for modern needs, and hence the North Holland Canal was made from the entrance to the Zuider Zee, and still later the more direct North Sea Canal was cut across the base of the North Holland peninsula.

Facilities for trade and for fishing led both to maritime power, which was very considerable in the seventeenth century, and to colonial acquisitions, now represented by Java and other East Indian islands and by Dutch Guiana and smaller West Indian possessions. Colonial produce is the chief export, followed by butter and cheese. Manufactured goods, wheat and oil are large-scale imports.

GERMANY, BOHEMIA-MORAVIA AND SLOVAKIA

Natural Regions.—*Western Marginal Lowlands:* The eastern portion of the North Sea Margin (B^2). *The Baltic Lowlands:* The western portion of the South Baltic Plains (H^3). *Central Uplands and Highlands:* The greater part of the Rhine Massif (K^3); the northern and eastern portion of the Rift Valley of the Rhine with its borders (K^4); the Uplands of the Main and Neckar Basin (K^5); the Uplands of the Weser Basin and Thuringia (K^6); the Bohemian Plateau (K^7); the north-eastern portion of the Alpine Foreland (K^8); the north-eastern part of the Alps (K^{10}); the Vienna Basin (K^{11}); the north-western part of the Carpathian Highlands (K^{12}).

Historical and Political Survey.—The Northern Plains and Southern Upland regions of the German Republic are peopled by representatives of the Northern and Alpine Races respectively, but no sharp line of demarcation can be drawn. The great mass of the people speak German, now that the Poles in the extreme east have in the main been incorporated into restored Poland. North-east of a line drawn from the Fichtel Gebirge to the mouth of the Ems, the people are mainly Protestant, while those of the south of the Republic are largely Roman Catholic. Of the

whole population about two-thirds are Protestants, and about one-third are Roman Catholics.

During the Middle Ages and until the time of Napoleon there was a German Empire comprising most of Central Europe, but very loosely held together, the many states composing it having very little in common. This was broken up by Napoleon, and after his fall in 1815 another loose confederation was formed, with Prussia and Austria as rivals for its leadership. This rivalry led to the war of 1866, when Austria was defeated by Prussia and left the union. In 1870 the Germans, under the avowed leadership of Prussia, defeated the French, and in consequence a united German Reich (i.e. Realm) was formed with the King of Prussia as the German Emperor. It then consisted of twenty-six states, and of these the kingdom of Prussia was by far the greatest, including two-thirds of the whole area and nearly two-thirds of the population. Berlin, the capital of Prussia, became the capital of the German Empire, and in this respect its development was similar to that of Paris. Like Paris, it is the centre of routes radiating to every part of the great northern plain, and "Greater Berlin," i.e. Berlin and its suburbs, has a population of over 4,000,000 people, being thus the largest city in the continent of Europe.

After the war of 1914-18, Germany became a republic. Its territory was considerably reduced, for it lost to France the Alsace-Lorraine area, to Denmark a strip of land across the Peninsula of Jutland which had previously been taken by Prussia, to Poland a part of Upper Silesia inhabited mainly by Poles and in the north-east a larger area including the "Polish Corridor" which detached East Prussia from the rest of Germany. With these areas, considerable populations were lost, and also natural resources especially the iron ores of Lorraine, and in Upper Silesia a large part of the coalfield and of the mines which yield iron, zinc and lead.

Also in 1918, Germany's ally, the Dual Monarchy of Austria and Hungary, collapsed. Large parts of its territory in which had lived subject-peoples were incorporated into the new States of Czechoslovakia, Poland and Yugoslavia, while another large area went to Rumania, and smaller ones to Italy. Austria and

Hungary were left as separate, small States ; German-speaking Austria had an area of about 32,000 sq. miles, and a population of over six millions.

In 1933 a new form of government was adopted in Germany and the Third Reich was constituted. A movement was begun with the aim of uniting as far as possible the German-speaking peoples in one realm, and in 1938 first all Austria was absorbed into the German Reich, and then the German-speaking parts of Bohemia and Moravia in Czechoslovakia. In March, 1939, most of the remaining part of Czechoslovakia was occupied by German troops, although only a very small proportion of the inhabitants were German-speaking people, about seven millions being Czechs living in Bohemia and Moravia, and about two millions being Slovaks inhabiting the north-western Carpathian region.

The Czechs and Slovaks, like the Poles, belong to the Western Slavs, as distinct from the Eastern Slavs or Russians, and the Southern Slavs or Yugoslavs. The Czechs for centuries had an independent Kingdom of Bohemia until this passed into the possession of Austria ; the Slovaks were under the Magyar rulers of Hungary almost throughout their history. As the Czechs and Slovaks were originally closely akin, their languages still resemble one another.

The Czech area was made the German "Protectorate of Bohemia and Moravia," ruled by a Governor appointed by the Head of the German State ; it became a part of the Customs Union of Germany, and its resources were organized as part of those of the Reich. Slovakia was made a State under the "protection" of Germany, which took powers to occupy part of the land with its troops ; the economic resources became practically, if not legally, at the disposal of the Reich.

The addition of the Czech and Slovak lands were of considerable assistance towards the German policy of self-sufficiency, i.e., making the Reich an economic unit which should be as far as possible independent of foreign imports, especially in time of war.

The German Reich is now by far the greatest and most populous of the States of "Peninsular Europe," i.e. excluding Russia ; with the Czech and Slovak lands, its area is about 260,000 square miles, and it has a population of about 90

millions. Comparing Germany with France, it is seen that the former has an area about 25 per cent. larger than the latter, but its population is more than twice as great. It is a country of large cities, for it has more than twenty with over 250,000 people, in contrast with four such cities in France.

The extent of Germany should be noted in connexion with its position, for it stretches southward from the North and Baltic Seas almost to the head of the Adriatic; thus it occupies the greater part of Central Europe, and almost separates the western from the eastern part of the Continent.

Forestry and Agriculture.—Nearly one-half of the surface is cultivated, one-quarter is covered with woods and forest, and of the remaining quarter two-thirds is pasture land. Since the forests are carefully managed and yield valuable timber there is only a small proportion of the land which can be called unproductive, and although Germany is a very important manufacturing and trading country, yet a third of the people obtain their living by forestry and agriculture.

The lands behind the North Sea coasts are largely treeless, the natural vegetation being of the moor and heath type, but behind the Baltic coasts the beech is very common and farther inland the woods are often of pine and birch, with oaks in some parts. The uplands bear the silver fir in the south-west (hence the name Black Forest Mountains), and farther to the east the spruce fir and pine from which the Fichtel Gebirge are named. These forests yield timber which is sawn by the water-power of the mountain streams and sent to many parts; they also give rise to local industries such as the clock and toy-making by the peasants of the Black Forest, and the burning of charcoal for fuel for the textile factories of Silesia.

In the Alps there is a succession of vegetation according to altitude: while in the valleys there is a little cultivation and the lower slopes have been cleared of trees to a considerable extent for pasture, there are some deciduous woods at moderate elevations and above them are the more extensive coniferous forests. Still higher are the areas which are covered with snow for much of the year, but have a low yet rich growth of herbaceous plants, forming "Alpine" pastures used as summer grazing for cattle,

sheep and goats. The central uplands of Germany, such as the Black Forest, also have somewhat similar summer grazing.

In Slovakia, the North-western Carpathians are largely clothed with beech on the lower slopes and firs on the higher parts, while alpine pastures are rare; sheep and cattle are mainly kept in the valleys and high basins of the larger rivers.

Of the crops, rye occupies the greatest area; "black" bread made from rye is still eaten in Germany. Wheat is grown to a considerably less extent, and assumes greatest importance in the south-west, mainly on the uplands around the Rift Valley of the Rhine. It must be remembered that because of the latitude, these uplands, which are rarely over 1,500 feet high, have a rather higher temperature in summer than the northern plains; indeed cultivation can be carried on to a height of about 3,000 feet. Oats and barley are also extensively grown.

In most parts of the country potato cultivation is important. Germany has a larger proportion of its area devoted to this purpose than any other country—three times the proportion in Ireland. The potato crop is used not only for food but for making brandy and other spirits; this is also one of the purposes for which the sugar-beet is cultivated, mainly in the centre and north-east of the country.

The very warm parts of the south-west yield (besides cereals) tobacco and hops, the latter being used in the important brewing industry of Munich. More valuable than these crops is the vine grown on the sunny slopes of the valleys of the Rhine and its tributaries, especially the Neckar, Main, and Mosel. Similar products are obtained from the fertile valleys of the Elbe and its tributary the Eger in the north of the Bohemian plateau.

The pastures once provided food for many sheep, and Saxony and Silesian wool were famous, but the number of sheep is now only one-third what it was thirty years ago. On the other hand, pig-keeping has increased at the same rate as sheep-rearing has diminished. Of still greater importance are the cattle of which the number has also increased, so that dairy produce is now obtained in all parts of the country.

Mining and Manufactures.—The production of coal in Germany is exceeded only by that in the United States and

Great Britain. Since the loss of part of the Upper Silesian coalfield, the reserves of lignite or brown coal have been greatly developed and are now increased by the addition of those in Bohemia; if this production is added to that of the better coal the total of Germany is greater than that of Great Britain. Peat is also used as fuel.

These sources of heat are in part utilised for the production of electricity, and for the same purpose is employed water-power, especially from the Alps. The current is fed into an electric "grid-system," which distributes power to all parts of the country for domestic, public and industrial uses.

The sources of power are an important factor in the growth of great manufactures which are aided also by very considerable deposits of iron and other minerals.

The largest deposits of iron ore are at Eisenerz, in the Austrian Alps, between the rivers Enns and Mur. Since the loss of the Lorraine mines, Germany has to import a large proportion of its iron ore, and in this connexion the Swedish supply is important.

Most of the coal is obtained from the border land between the northern plain and the central uplands, the chief exceptions to this rule being the coalfield in the basin of the Saar on the south-western border of the Rhine Massif, and two coal basins west of Prague in Northern Bohemia. The chief of the coalfields is that in the valley of the Ruhr; here is the mining centre of Dortmund, and farther down the valley is the great group of industrial towns, including Essen, Bochum, and Gelsenkirchen, where chemicals and all manner of iron and steel goods, including armaments and structural steel for bridges and buildings, are made. Where the Ruhr enters the Rhine is the river-port Duisberg.

Immediately to the south of this lowland industrial area, the uplands are cut by the Wupper and near its junction with the Rhine are the steel manufacturing towns of Solingen and Remscheid. Farther up the Wupper is a long group of settlements including Barmen and Elberfeld and now known collectively as Wuppertal; here textiles and chemicals are manufactured. West of the Rhine between the Ruhr and Cologne are other

industrial towns, prominent among which is Krefeld, the largest silk- and rayon-manufacturing centre of Germany.

South-west of the Cologne area, on the edge of the Ardennes Upland, is the small coalfield of Aachen (Aix-la-Chapelle).

In the uplands of Saxony near Chemnitz, are several coalfields which have now only a small production; in this district are important textile and metal industries, carried on in recent years largely by fuel and power brought from a distance. To the north, in the "lowland triangle" of Saxony, is the large city of Leipzig, famous especially for printing and publishing business.

In Bohemia, under the edge of the Erz Gebirge, is the valley of the Eger where lignite deposits have aided the growth of manufactures of porcelain, chemicals and other goods. A little to the south, the coalfields near Prague (Praha) and Plzen (Pilsen), with iron and other raw materials in the same neighbourhood, are the basis of various industries in these and other towns of this part of the Czech lands; in Moravia textiles are an important product of the factories of Brno (Brünn) and other centres.

The other valuable coalfields are in Silesia: one among the Sudetes near Breslau, the other at the south-eastern extremity of Silesia, where Hindenburg, Beuthen and Gleiwitz are the chief towns.

The Harz Mountains, which form the highest portion of the Weser Uplands, are the centre of a very varied mining industry, for in this region there are lignite, some iron ore and other minerals, in addition to great quantities of potash salts and rock salt not far distant. On account of this mineral wealth there are a number of chemical works at Stassfurt, and the products of the salts are used in the manufacture of textiles and in many other industries both of Germany and of other countries. The salt deposits near Salzburg, on the margin of the Austrian Alps, are of importance.

Communications and Commerce.—The Rhine Valley provides the greatest trade route of Germany, both on account of the resources and population in its immediate vicinity and as affording a route from northern to southern Europe. The river itself has the advantage of a more uniform flow of water than the less

complex rivers of the north German plain (see p. 328). It has, moreover, been artificially improved so that sea-going steamers land their goods at Cologne, a river-port having the further advantage of being on the railway route which there crosses the river in skirting the north-western edge of the Rhine Massif. Farther up the river is Coblenz, at the confluence of the Mosel and Rhine. In this part of the course the narrow valley has railways close to the river on both banks. At the northern extremity of the Rift Valley is Mainz, where the Rhine receives the Main, and higher up the river is Mannheim at its confluence with the Neckar. Mannheim is a great river-port, for above it the depth of the river is less and its current swifter, so that only the smaller boats and barges can ascend to Strasbourg. This French town is the head of the important navigation of the Rhine system, although some distance up the tributary the Ill, for it is at Strasbourg that the canals from the Marne and Rhone enter the Rhine system. Recent improvements in navigation have led to an extension of the Rhine traffic to Basel, though even yet the traffic is relatively small beyond Strasbourg.

From Mainz the great routes from the north lead either southward through the Rift Valley or eastward up the Main. Navigation of large vessels is continued up the Main as far as the great commercial and industrial centre of Frankfurt-on-Main; traffic by water continues far up that river, and thence southward by the new Rhine-Main-Danube canal which follows the course of the old Ludwig's canal to the Danube which it joins near Regensburg (Ratisbon). Thus the Rhine-Main-Danube canal links the two most important natural waterways of Europe. Where this canal leaves the Main system Nuremburg is situated, but the importance of this city is due rather to road and rail traffic, for the route just mentioned has been for centuries one of the chief ways from the north-west to Vienna and the east. This is the present route of the Ostend-Vienna express, that of the Orient Express goes from Paris by the Marne Canal route to Strasbourg, and thence by Stuttgart and Munich to the Danube.

Vienna is not only on the route from north-western to south-eastern Europe and beyond; it is where routes from southern Europe and the Adriatic, having crossed or skirted the Alpine

barrier, cross the Danube to north-eastern Europe. It became one of the chief cities of the world when it was the capital of the Austrian Empire, and although it has now lost much of its political significance it still has a population of over 1½ millions.

After the German occupation of the Czech and Slovak lands, the Morava river and the traffic associated with it, together with the river-port of Bratislava just below the junction of the Morava with the Danube, became part of the German economic system. Thus the Danube has assumed greater importance to German trade, and this trade, moreover, has been increasingly fostered with the countries which are situated to the south-east. A further link in the chain of German water-communications will be forged by the construction of a canal connecting the Oder in Upper Silesia through Moravia to the River Morava and the Danube.

Of the German traffic-ways in the Alpine region, one of great importance is that which leads southwards from Munich to Innsbruck in the valley of the Inn, thence to the Brenner Pass, and so to the Adige valley and Northern Italy.

Of the rivers of the northern plains the Ems is connected with the Rhine district by a canal from the Ruhr coalfield at Dortmund, and the Mittelland canal links this system with that of the Weser, passing through Hanover and near Brunswick and continues eastward to join the Elbe near Magdeburg. Most of the traffic of the Weser region passes through Bremen, which is situated just above the estuary of the river.

The Elbe system has a much greater significance; it is easily navigable from Prague on the tributary the Moldau (Vltava) in Bohemia, and on the Elbe itself are Dresden and Magdeburg, the latter situated at the sharp turn to the north-east. At the head of the estuary is Hamburg (with Altona), the greatest port of Germany and indeed of the whole of continental Europe; thence a canal passes to Lübeck, giving immediate access to the Baltic Sea.

The Upper Oder runs parallel to the Upper Elbe and is navigable for all the German part of its course. Breslau occupies on the Oder a position similar to that of Dresden on the Elbe, and Frankfurt is near the turn of the Oder, where the Friedrich

Wilhelm Canal joins the Oder to the Spree on which Berlin stands. The Spree joins the Havel, and the Havel runs into the Elbe, so that there is an unbroken waterway almost in a straight line from Upper Silesia through Breslau, Berlin and Hamburg to the North Sea. Traffic from the Oder Basin to the Baltic would proceed down the river to Stettin at the head of its estuary, and to this port water traffic might also go from Berlin by passing northward up the Havel and by the Finow Canal across the low water-parting to the lower Oder. The Vistula turns sharply to the north-east at Bromberg, and as the Netze rises near this point, the Bromberg Canal joins the Vistula to the Netze so that traffic may go westward by way of the Netze, Warthe and Oder and so to central Germany and the North Sea. At the mouth of the Vistula is Danzig, on the Gulf of Danzig, and at the north-eastern extremity of the same gulf is Königsberg.

The freezing of the Baltic ports in winter gives a great advantage to Hamburg, which is always ice-free, and can gather the traffic by river, canal, road and railroad from the whole of the centre and east. The time during which the Baltic ports are closed by ice is less in the west than in the east, so that Stettin is more favoured than Danzig, and Königsberg used to act as a port for Russia when Riga and Leningrad were ice-bound.

The great railway routes from western Europe to northern Germany and to all parts of Russia enter the central part of the northern plain by the Westphalian Gate, pass through Hanover to Berlin, and there diverge to the north-east by Königsberg to Leningrad, to the east by Warsaw to Moscow, and to the south-east by Breslau to Odessa.

The foreign commerce of the German Reich somewhat resembles that of the United Kingdom, for in the imports manufactures have but a small place, and food supplies and raw materials are far more important. Germany, however, is not so dependent as Britain upon foreign sources for its food, the chief articles needed being wheat and coffee ; its import of raw materials is relatively greater, and of these iron ore, cotton, wool and mineral oil are the chief commodities. The bulk of the outward trade, with the exception of coal, is in manufactured goods, iron and steel goods and machinery ranking first, followed

by dyes and chemicals, and these again by glass ware, paper and textiles.

The Outbreak of War, 1939.—When Germany occupied Czecho-Slovakia in March, 1939, two facts became apparent: (1) that the policy of the German Government was to incorporate into the Reich not only the areas inhabited by German-speaking peoples, but also other territory which might be desired because of its economic or strategic value, and (2) that the undertakings of the German Government might be dishonoured if it seemed to be to their advantage.

Shortly afterwards, negotiations took place between Germany and Poland regarding Danzig and the "Polish Corridor." Danzig was a Free City legally under the protection of the League of Nations, but inhabited mostly by Germans, and in practice controlled by the German Government; also, to ensure that Poland should be able to import and export its goods through Danzig, which is at the mouth of the Vistula—the artery of the river-borne trade of Poland, the Free City was included in the customs area of that State. The "Polish Corridor," which separated East Prussia from the rest of the Reich, had been part of Poland until taken by Germany at the end of the 18th century and had been returned to Poland after the war of 1914-1918; it is inhabited by a Polish majority and gives Poland an outlet to the Baltic Sea.

In April, 1939, Germany demanded Danzig and a narrow strip of territory across the Corridor. This was refused, as it would exclude Poland from direct communication with the sea, and it was feared that Poland's economic and political independence would be jeopardised. Germany then denounced the pact of non-aggression she had made with Poland. Britain and France consequently promised to aid Poland should her vital interests be attacked. In the following months the German Government made preparations for an attack, and after insisting upon the immediate acceptance of demands never clearly specified, invaded Poland on September 1st, 1939. Britain and France, seeing in these actions a repetition of the previous dominance of other States by Germany, carried out their undertaking to Poland, and declared a state of war with the Reich on September 3rd, 1939.

SWITZERLAND

Natural Regions.—*Central Uplands and Highlands:* The eastern portions of the Jura Mountains (K^9); the south-western part of the Alpine Foreland (K^8); the northern part of the central Alps (K^{10}).

Historical and Political Survey.—As the position of Switzerland would suggest, its people are largely of the Alpine Race, but there has been a considerable intrusion of the Northern Race. In the north the people speak German, a legacy of the over-running of the country by a Germanic tribe after the fall of the Roman dominion, but French is spoken in the south-west and Italian in the south-east. Three-quarters of the people speak German, and of the remainder three-quarters speak French; hence Italian is spoken only by a small proportion of the population. In the higher valleys of the Vorder Rhein and the Hinter Rhein, Romansch, a distinct language derived from Latin, is still preserved. About three-fifths of the Swiss are Protestants, the remaining two-fifths being Roman Catholics.

At one time this region formed part of the ancient Roman Empire, and in the thirteenth and fourteenth centuries struggled against Austrian government. The commencement of the present system was the union of three Cantons, i.e. small states, which lay around Lake Lucerne. This was in 1291, and since then the Cantons have increased till they now number twenty-five. The mountain barriers have helped the Swiss to preserve their independence, and helped also to retain the individuality of the Cantons, which have their own government for local matters, combining for common purposes into the "Swiss Confederation," at the head of which is an annually elected President; the capital, Bern, is a convenient centre of the Confederation, and lies on the Loetschberg Tunnel route to the Simplon Pass. The area is about half that of Scotland; the population about 4,000,000.

The beauty and grandeur of the Alpine mountains, glaciers and lakes attract many visitors, especially in the summer. These give rise to the "tourist industry" which is of considerable

value to Switzerland, and Lucerne is one of the towns which have gained importance as tourist centres.

Agriculture.—A country formed so largely of high mountain masses necessarily has a large amount of unproductive land; in Switzerland it amounts to nearly one-quarter of the whole area. Grassland and rough pasture together cover nearly one-half of the country, for the high altitude and the heavy summer rainfall are both unfavourable to crops. All parts of the Alpine Foreland have pasture lands, and in addition the higher "alps" are utilized in summer, the animals being taken in winter to the lower valleys. Cattle are many times as numerous as sheep, but goats also are reared, especially on the more mountainous parts. In consequence, the making of cheese and of condensed milk and milk chocolate are important industries.

Very little of the land bears fruit trees or crops; these are distributed over the Alpine Foreland and the warmer valleys. The soil of the Foreland is rich only where the Alpine rivers have deposited alluvium, but cultivation is widespread, for the elevation ranges from 1,000 feet in the Rhine valley below the confluence of the Aar, to 3,000 feet at the base of the Alps and the Jura, and so the summer temperatures are approximately equal to those of the plains of France. Wheat, rye and oats are the chief cereals, and the vine is grown where shelter and sun are obtainable, mainly on the southern slopes of the Jura and north of Lake Geneva. In the warm Ticino valley the mulberry is grown for the rearing of silkworms.

Most of the remaining quarter of the country is forest covered; the Foreland has beeches, the mountains bear coniferous trees, and on the Italian border the valleys have oaks and chestnuts.

Manufactures.—Switzerland has very poor mineral resources, and its manufactures are carried on either by a little imported coal, by the water power of many of the streams, or by hand. Raw material has to be imported; hence there is little beside the training and skill of the people and the abundant water power to make Switzerland, as it is, an important manufacturing country. The water power is applied electrically to industries and transport. Zürich and other Swiss towns are famous for hydraulic and electric apparatus, some of which is exported.

Cotton manufacture is important; it is carried on in the belt of country at the base of the Alps from Bern to Lake Constance. The silk and artificial silk industries are centred specially at Zürich and Basel (Bâle), the largest towns. The making of watches is a considerable industry in the belt of country at the base of the Jura including Geneva, Neuchâtel, and Basel. The chemical industry is of growing importance.

Communications and Commerce.—The chief routes of communication with other nations are quite definite. At the point where the Rhine enters Germany is Basel; near the entrance of the Rhone into France the town of Geneva has grown up; in the north-east a railway leads, by the Arlberg tunnel, to the Inn valley in German territory; in the south are two railway routes into Italy, one by the Rhone valley and the Simplon Tunnel to the valley of the Toce, the other by the Reuss valley and the St. Gotthard tunnel to the Ticino valley. The railway system of the north-east of Switzerland is well developed, and centres at Zürich.

The foreign trade is that of a typical manufacturing community, the imports being largely of food and raw materials, the exports of manufactured goods.

HUNGARY

Natural Regions.—The Upper Hungarian Plain (L^1); much of the Lower Hungarian Plain (L^2); part of the Carpathian Mountains (K^{12}).

Hungary is the land of the Magyars; they were originally of Ugro-Finnish descent, but in physical characteristics have become almost assimilated to the Europeans around them. Yet they have their own language and in the past obtained dominance over the Rumanians and Slavonic peoples formerly included in Hungary. After the partition of the old Kingdom in 1909 the new State retained only lowland territory in part of the Upper Hungarian Plain and in the adjoining area of the Lower Hungarian Plain, together with the uplands separating them, viz. the Bakony Forest and the Matra Mountains across the Danube. With the less of the rest of the Kingdom many Magyars were also included in the neighbouring States of Czechoslovakia, Rumania, and Yugoslavia.

In 1938 Hungary regained from Slovakia the lowlands adjoining the Danube in the Upper Hungarian Plain, and in 1939 the break-up of Czechoslovakia gave Hungary the opportunity of occupying Ruthenia, where the upper Tisza collects the streams from the southward-facing slopes of the Middle or Forest Carpathians. In the lowland part of this area the people are Magyars, but the Carpathian valleys are inhabited by Ruthenians who speak the Ukrainian language, and for this reason the territory was sometimes known as Carpatho-Ukraine. The Ukrainians here are akin to those in the adjoining districts of Poland, Rumania, and the Ukraine Republic of Russia. The Ukrainian speech is classified as Little Russian, to distinguish it from the allied Great Russian and White Russian languages.

The area of Hungary is now about four-fifths that of England and Wales, and the population amounts to about 11 millions, including a considerable number of Slovaks and Ruthenians.

By the annexation of Ruthenia, Hungary has obtained a further part of the Lower Hungarian Plain, and also part of the Carpathian Mountains which gives it a supply of timber with which the country is otherwise poorly endowed. The chief mineral production is of coal and lignite, especially from the upland near Pécs; bauxite, from which aluminium is obtained, is the only other important mineral produced in Hungary. The wealth of the country is based mainly upon the production of great quantities of wheat and maize, other cereals to a less extent, and fruit (including the vines specially noted in the Tokay region), and the keeping of animals, especially cattle and pigs; the horse-rearing on the pusstas has been famous for centuries.

Budapest is the capital with over a million inhabitants, carrying on milling, sugar refining and other small industries. Szeged and Debrecen are agricultural centres. Grain, flour and animals form the chief exports.

POLAND

Natural Region.—Part of the South Baltic Plains (H^3).

Over one hundred years ago Poland was divided between Russia, Prussia and Austria; it is now reunited, although its boundaries are not identical with those of the past. The area

of the Republic is rather greater than that of the whole of the British Isles and its population is about 35,000,000 people. This includes not only Poles but also a considerable number of Russians, some Germans, and two or three millions of Jews.

All of the central part of the country is drained to the Baltic Sea by the Vistula. It is partly for this reason that a belt of Polish territory projects along the river to the Baltic Sea between East Prussia and the rest of Germany. The city of Danzig, however, inhabited largely by Germans, was made a free city under the protection of the League of Nations after the war of 1914-18. It continued to carry on some of Poland's trade, although not part of the State, but a new port, Gdynia, was developed in the Polish "Corridor" west of Danzig.

Agriculture is the main occupation of the country, producing rye and oats, barley and wheat, potatoes and sugar beet. Large numbers of cattle, pigs and horses are reared, and about one-fifth of the country is still covered by forests. In Upper Silesia is a considerable coalfield, and in this district iron, zinc and lead are also mined and smelted. The coal is partly exported, and partly used in the manufactures of Warsaw and Lodz, largely textile. The Carpathian Foreland yields common salt, potassium salts, and petroleum. Warsaw, with about a million people, is the capital, well situated on the Vistula in the centre of the country. Cracow and Lwow (Lemberg) are on trade-routes skirting the Carpathians.

BALTIC STATES

Natural Regions.—(1) Estonia, Latvia and Lithuania form part of the South Baltic Lowlands (H^3); (2) Finland includes part of the North Baltic Lands (H^1), the lower north-eastern part of the Scandinavian Fjeld (A^1), and the western extremity of the Tundra (A^2).

These four Republics may be grouped according to position as those lying to the north and to the south respectively of the Gulf of Finland, but from the point of view of the peoples the division is different. The Finns and the Estonians must be placed together, for they were both non-European in origin, being derived from the Ugro-Finn Race, while the Letts of Latvia (sometimes called Lettland) and the Lithuanians belong to the Northern European

Race. They are quite distinct from the Germans in descent and in language.

The three southern states have no mineral wealth ; they are dependent almost entirely upon agriculture and the keeping of animals, and as their land is favoured neither by soil nor by climate, the population is small, about 6,000,000 in all. The chief crops are rye, oats, hay, potatoes, and flax, the last being a valuable export. The timber resources are great. Estonia has the port of Tallin (Reval), and Latvia the ports of Riga and Libau, the latter being ice-free in the winter. Riga, with less than half a million people, has manufactures as well as commerce, and it is the capital of Latvia ; Tallinn is the capital of Estonia, and Kovno, on the Niemen River, is the seat of the government of Lithuania. Memel is German, but Lithuania has a "free zone" for its commerce in the port.

Finland has about 4,000,000 people, including some Russians, and along the southern coast some Swedes. This southern strip is by far the most important part of the country, the more northern part consisting mainly of lake, marsh, coniferous forest or tundra. Agriculture and animal-rearing are the mainstay of the people, forestry supporting others, while the small amount of manufacturing is largely dependent either upon the forests (paper and other products of wood) or upon imported iron ore and cotton yarn. The chief town and port is Helsinki (Helsingfors), with about 300,000 inhabitants.

Timber, wood-pulp, paper and butter are the leading exports, while cereals, colonial wares, metals and manufactured goods are imported. Increasing use is being made of the abundant water-power for industrial development.

For authorities and books for further reading, see end of Chapter XXIII.

CHAPTER XXIII

EUROPE—POLITICAL AND ECONOMIC CONDITIONS—*Continued*

DENMARK

Natural Regions.—*Western Marginal Lowlands:* North Sea Margin (B^2). *Baltic Lowlands:* The western margin of the Baltic and the islands (H^3).

Historical and Political Survey.—The peninsula of Denmark and the southern part of the Scandinavian peninsula have had a very closely connected racial and political history. Denmark, Norway and Sweden are sometimes collectively referred to as "the Scandinavian States." In all these countries the people are mainly of the Northern or Nordic race, but in several parts there are traces of early Alpine and even Mediterranean immigrants. Politically all this region has been united under Danish rule, but first Sweden and then (in 1814) Norway became independent of Denmark. The past power of Denmark brought to it colonies, but these now consist only of some small West Indian Islands, the Faroe Islands and Greenland; Iceland has an independent government, but owns the supremacy of the King of Denmark.

Denmark has an area about equal to that of Switzerland, about one-third of this consisting of the islands of the Baltic, the largest of which are Zealand, Laaland and Funen. The resources of the country are not great and the population is nearly 4,000,000 persons. More than half of these live on the Baltic Islands, and on Zealand stands the capital, Copenhagen; this is the only city of importance, but it has one-fifth of the total population. The established religion is Protestant, and to this faith nearly all the people adhere.

Agriculture.—Denmark is the only country of Europe which has no land above 600 feet high, but the east of the mainland and

the islands are somewhat hilly and correspond to the Baltic lands of Sweden and Germany. Here is the chief agricultural portion of the country, and three-quarters of the total surface is to some extent productive. Of this about half is cultivated, producing oats, barley and rye, and half is pasture-land which supports a large number of cattle. The production of dairy produce is carried on so efficiently and is so well organized that it has become the chief industry of the country. The beech forests which once covered the land now occupy only a small percentage of the area, but they afford part of the food for the pigs which are reared in considerable numbers.

The western portion of the peninsula faces the North Sea and is largely composed of low hills of sand driven inland by the sea winds; here little is produced and few people live.

The absence of minerals is the cause of the absence of any but small manufactures.

Commerce.—The commercial position of Denmark is advantageous only in respect of the sea traffic between the Baltic and North Seas. Copenhagen has a considerable trade, as it commands the most direct route, namely, that through the Sound, but the largest vessels must traverse the deeper Great Belt; moreover, the opening of the Kiel Canal has tended to reduce the importance of Copenhagen. On the east coast of the peninsula there are only small ports, and on the North Sea coasts there is only one good harbour, Esbjerg, which trades with the British Isles.

The bulk of the imports is of manufactured goods, fuel and feeding-stuffs, while the exports reflect the pastoral character of the country in the predominance of butter, and live animals, namely cattle, pigs, and horses, besides bacon and eggs.

THE SCANDINAVIAN PENINSULA

Natural Regions.—*The Cold Deserts:* The Scandinavian Fjeld (A^1). *Transition Region:* The North-western margin (A–B^2). *Western Marginal Lowlands:* South-west of Scandinavia (B^1). *Baltic Lowlands:* Northern Sweden (H^1); Southern Sweden (H^2).

Historical and Political Survey.—The great majority of the

population of Scandinavia belongs to the Northern European Race, and the intrusion of Lapps and Finns into the north of the peninsula has not been numerically great, for of each race there are only about 30,000 people, most of the Lapps being in Norway and most of the Finns in Sweden. The mountain barriers between Norway and Sweden and the fact that one faces the North Sea and western Europe, while the other faces the Baltic Sea and eastern Europe, have enabled separate nations to evolve. At times they were connected with each other or with Denmark, but Sweden, being greater and richer, at one period gained considerable power, and when Denmark lost its supremacy over Norway the two parts of the peninsula united, with Sweden as the predominating partner. Only in 1905 did Norway become a separate kingdom.

In Sweden there is a quite distinct Swedish language, but Norway, owing to its longer political association with Denmark, has a language closely akin to Danish; in both countries the Protestant faith is professed.

Norway has an area equal to that of the British Isles, but so poor are its resources that this land supports rather less than 3,000,000 people. Sweden is half as large again and has rather more than 6,000,000 people. Consequently, the average density of population of these countries is much less than that of any other country of Europe.

Norway's capital, Oslo (formerly Kristiania), has about 300,000 people, and that of Sweden, Stockholm, about 600,000 inhabitants.

Agriculture, Forestry and Fishing.—The northerly situation and the height of much of the peninsula are the causes of the extremely small agricultural production. It is very difficult to say how much of the area is used for pastoral purposes, for poor mountain pasture utilized only during a part of the summer cannot be classed with the better meadow-lands, but the amount of land that bears crops other than grass gives a striking indication of the condition of agriculture. In Norway it is about 4,000 square miles, that is less than 4 per cent. of the whole area of the country, and about equal to the county of Yorkshire. This crop-land exists partly as small patches on the sides and at the heads of the fiords of the western shores, but the largest part

occurs in the coastal lowland around Oslo; only in this part is the population at all considerable. Half of the crop area is devoted to oats, and barley and potatoes rank next.

In Sweden the crop-land is more extensive and yet is less than 10 per cent. of the area; it is most developed in Scania, the low southern projection of the country, and especially in the coastal lands bordering the Kattegat. Oats again take the first place, but there are also considerable crops of wheat and rye.

Cattle are the chief animals in both countries. The number reared in Sweden (3,000,000) as compared with the number reared in Norway (1,300,000) is determined rather by the comparative amounts of lowland than by the total area of the two countries.

Forests of pines and firs occupy nearly a quarter of the land of Norway and more than half that of Sweden. Consequently timber and turpentine rank as important products of the peninsula.

The long and deeply indented coast-line encourages fishing, to which many of the people have to look for part of their sustenance, and the shallowness of the North and Baltic Seas is an additional advantage in this respect. The Norwegians obtain far more fish than the Swedes; the chief kinds are the cod which are caught within the 100-fathom line, the herring from the fishing grounds just beyond that line, and the whale and seal of more distant Arctic waters. The curing of fish is therefore an occupation of some importance.

Mining and Manufactures.—The mineral wealth of Scandinavia is considerable, consisting largely of iron ore, much of which is of remarkably good quality. It is found in Sweden to a much greater extent than in Norway, and mainly in two districts, one in Lapland between Lake Tornea and Gellivara, the other north of Lakes Vener and Mälar. Copper is obtained from the north-western highlands of Norway. Very little of the iron ore is smelted in the country owing to the scanty supply of coal. Indeed charcoal is here used for smelting and the quality of the iron is thereby improved.

The mechanical power for manufacture is already obtained to a considerable extent from the highland streams, and there can be no doubt of further developments in the use of water power for many purposes, including railway transport. At

present it is used largely in the timber industries, namely, in the saw-mills for the timber exported, in other mills where wood is pulped for the manufacture of paper, and in the manufacture of matches and boxes. It is also used in the production of chemicals for manures, and in the metallurgical industries.

Communications and Commerce.—Four lines of railway traverse the plateau ; one goes from Bergen to Oslo, two diverge from Trondhjem, one south to Oslo and the other east and then south to Stockholm, while the fourth passes from the head of the Gulf of Bothnia through the Gellivara iron district to take the ore to the Norwegian port Narvik, which is always ice-free. The other Norwegian ports, Trondhjem, Bergen and Oslo, are either almost or entirely free from ice, but the Swedish ports are more obstructed. Göteborg (or Gothenburg) is the chief port of Sweden as it faces the western world, is closed only for a short period, and is connected with the Baltic Sea by a ship canal which makes use of the Lakes Vener and Vetter. Stockholm, on the channel between Lake Mälar and the Baltic Sea, has less trade because it is closed in winter and looks only toward Russia. The trade with Germany passes largely through Malmö.

The exports of Norway are largely the produce of the forests and fisheries ; those of Sweden are much greater in value, and here again the forest products come first, followed by iron and steel goods, including machinery, and iron ore.

In both countries the chief imports are textile and other manufactured goods, corn and flour, and coal and other forms of fuel.

RUSSIA

[UNION OF SOCIALIST SOVIET REPUBLICS (U.S.S.R.)]

Natural Regions.—*Cold Deserts :* Part of the Fjeld (A^1) ; The Tundra (A^2) ; the N. Ural Mountains (A^3). *Baltic Lowlands :* East part of the Baltic Plains (H^3). *The Russian Forest :* North-eastern Russia (M^1) ; Central Russia (M^2). *European Steppes :* The South Russian Plain (N^1). *The Mediterranean Regions :* The Southern Crimea (D^7) ; the Rion and Kur Valleys (D^8). *The Caucasus Mountains* (G). *The Caspian Depression* (O).

Historical and Political Survey.—The great bulk of the population consists of the true Russians who are Slavs and therefore of the Alpine Race. The chief peoples of Asiatic descent are found in the east, namely the Mongolian Kalmuks and the Turki tribes, including the Kazaks (or Kossacks) and the Tatars. Many Jews are scattered throughout the country, especially in the south-west, and the Caucasus region, as stated in Chapter XII, is the home of a medley of races.

According to the present Constitution, the U.S.S.R. is a Socialist State of Workers and Peasants. No distinction is made between the European and Asiatic sections of the country.

The Russian power that arose in the forest region, and was centred at Moscow, gradually extended over the great plain ; even the steppes which gave access to Asiatic horsemen were at last occupied. Thus the whole of eastern Europe was in the hands of one government, and that government also enlarged its dominion till it extended eastward across the grasslands which stretch into central Asia and the forests which reach to the Pacific. The uniformity of the plain and the absence of natural barriers prevented the growth of strong local differences and enabled the central government to impose its will upon every part. The relative isolation of this part of Europe also contributed to produce a form of government and a degree of civilization both much less advanced than those of the western states. To get into touch with these states Peter the Great founded a new capital, St. Petersburg, at the mouth of the Neva, and at the head of the Gulf of Finland. This city, now called Leningrad, has about 3,000,000 people, but Moscow has again become the capital, and has about 4,000,000 inhabitants. After the Revolution of 1917, which destroyed the Empire, Poland, Finland and the Baltic States obtained their complete independence, and the remaining territory has been formed into the Union of Socialist Soviet Republics. The Soviets (*i.e.* Councils) of Russia proper, of self-governing republics such as the Kalmuck, Tartar, Daghestan, Bashkir, Crimea and Karelian regions, and of other autonomous areas such as the far eastern part of Siberia, unite to form the Russian Federal Soviet Republic, and to this State there are federated other republics, viz. White Russia ; the Ukraine ;

the Transcaucasian Republics of Armenia, Georgia and Azerbaijan; the Kirghiz, Turkmen, Tadzhik, and Uzbek Republics in Asia south of the Sea of Aral.

The total area of the U.S.S.R. is 8 million square miles, of which 2 millions are in Europe. The total population is over 180 million people, of whom over 100 millions live in the European part of Russia proper (including the Urals), over 35 millions in the Ukraine, and 6 millions in White Russia.

Agriculture and Forestry.—Largely owing to the uniformity of the surface a distinct zonal arrangement is noticeable in Russia in regard to agriculture. Bordering the Arctic Sea is the practically barren tundra, and to the south of this are the vast forest areas which still occupy 40 per cent. of the whole country. The distribution of these is indicated on the maps; from the coniferous forest area of north-eastern Russia the pine, spruce and larch are obtained, while in the much smaller broad-leaved forest of Central Russia the oak, ash, and lime are common. The furs from the animals of the northern forests are still of considerable value. But where the climate favours the growth of crops, and therefore particularly in the deciduous portions of the forest, great clearances have been made for agricultural purposes.

The cultivated land extends from the shores of the Black Sea as far north as latitude 60°; beyond this and east of the lower Volga few people can obtain a livelihood. In this socialist State, nearly all the cultivation is by the collective work of the peasants organised in "collective farms"; there are also some "State farms," but few individual farmers.

The most northerly of the crops is barley which ripens in a short summer, but the amount is small. The most extensive crop in north Russia is rye, for it stretches right across the forested area to the south of latitude 60° in a belt ten degrees wide, therefore including also a part of the extraordinarily fertile black-earth region. Oats are an important product grown in much the same region as rye, with the exception of the most northerly strip.

South of the rye and oats belt in the South Russian Plain the other great grain crops are found. Wheat, the most important product, is largely grown in the black-earth region and the rest of the steppe-land from the Ukraine north-eastwards to the

southern Urals, and south-eastwards to the Caucasus. In the west of this wheat belt, maize is largely grown, while in the east of it (where the summers are shorter) barley takes its place; the total area given to barley is, however, greater than that given to maize, as it also extends southward to the western portion of Caucasia. Flax is grown over a very wide range of latitude, for it is found with the rye in the north and with the barley in the south; sugar-beet is important, but its area does not reach so far to the north. Potatoes are largely grown, especially in the regions extending eastward from Poland. In the regions of the Mediterranean type and in the valleys of the Kuban and Lower Volga the vine and other fruit trees are cultivated.

The agricultural productions are very important, as it is by them that the population is fed. Russia has held the first place in the world's supply of rye, barley, flax and hemp, and first or second place in that of wheat and oats.

Many millions of sheep are kept in the steppe lands, though less now that the cultivation of the ground has become so widely undertaken, and in the same region cattle and horses are reared in great numbers; cattle and pigs are important throughout the country. On the tundra and the poorer steppe and scrub lands the pastoral peoples are still nomadic.

Mining and Manufacture.—The U.S.S.R. is rich in minerals, including gold, copper, nickel, chromium, manganese, bauxite, platinum, besides coal, iron and petroleum. All these are found in or near the Urals, and several in the Kola Peninsula of the far north.

In recent years the production of coal and iron has become very important and is in part the basis of manufacturing which has developed greatly in three areas. (i) Coal is found in the central Urals and iron is mined in large amounts in the south, especially at Magnitogorsk. Hence in and near these mountains are important metal industries and large cities; Sverdlovsk (Yekaterinburg) has about half-a-million inhabitants. (ii) Another coalfield is near Tula south of Moscow. With the aid of local coal, an extensive manufacturing region has grown up, between Moscow and Gorky (Nizhni Novgorod); here textiles of wool, flax and cotton are made. (iii) In the steppe-lands is an important coalfield within the eastward bend of the Donetz river; in the

same district iron is found, and west of this there is a still greater production of iron ore within the eastward bend of the Dnieper. The fact that the Ukraine possesses these stores of coal and iron, the most fertile lands north of the Black Sea, and a frontage upon the sea, makes it the most important region of Eastern Europe. Smelting is carried on in the Donetz and Dnieper districts, and an industry producing many kinds of iron and steel goods and chemicals has developed at and near Dniepropetrovsk (Ekaterinoslav) using hydro-electric power from the rapids of the Dnieper. A line of industrial towns from Rostov-on-Don westward along the north shore of the Sea of Azof takes advantage of water-transport as well as the proximity of the coal and iron.

In the production of petroleum Russia is second only to the United States. The oil is obtained from the northern and southern slopes of the Caucasus Mountains, especially around Baku, the third city of the U.S.S.R.; it is exported from Batum on the Black Sea, to which place oil from Baku is transmitted by means of a pipe over 500 miles long. Among other minerals may be mentioned the salt from the salt swamps in the depression from which the Caspian Sea has retreated.

Since the State took over the natural resources, with the factories, railways, etc., there has been an enormous increase in all kinds of manufacturing; indeed, Russia has suddenly experienced an "industrial revolution" and is now one of the greatest industrial countries of the world.

Communications and Commerce.—Much of Russia is so flat that it is in parts marshy, and wide areas are flooded after the rapid thaw of the snows in spring; moreover, in the grassland region there is neither stone nor wood for the construction of firm roads. Hence until the advent of railways the rivers were the chief means of communication.

The rivers are long and therefore slow, and navigable for the greater part of their lengths, though to some extent impeded by the spring floods and the summer droughts and consequent shallows. A more serious and permanent difficulty is the blocking by ice for at least two months each year. The immense system of the Volga provides navigable waterways for a considerable part of the country, for example from Perm on the

Kama in the east to Moscow on the Moskva tributary of the Oka in the centre, but it has its value greatly diminished by flowing into the enclosed Caspian Sea. The Dnieper and its tributaries form another great system in the west, since a canal avoids the rapids below Dniepropetrovsk.

Moreover, all the chief rivers have been connected by canals. From Leningrad improved waterways join the Neva to Lakes Ladoga and Onega ; thence the White Sea canal goes northward to the Arctic, while others lead eastward to the Dvina River and, more important, southward to the Volga and thence to the Moskva at Moscow. A very important link is projected from Stalingrad (Tsaritsin) where the Volga nearly approaches the Don, to that river at Kalach ; thus the Volga system will be given a Black Sea outlet.

The great railway centre of Russia is Moscow, whence lines radiate to every part except the extreme north-east. As there are no great physical obstacles to construction, a railway map of this country is a good index to the productive capacity of the different portions, the closeness of the network of the lines indicating the amount of goods and the number of passengers to be carried. The routes to Asiatic Russia diverge from Kiubishev (Samara), the Siberian Railway proceeding to the east and that to Russian Turkestan to the south-east. South of the Caucasus Mountains, the Black and Caspian Seas are connected by a railway passing through Tbilisi (Tiflis), the chief city of the Trans-Caucasian Republics ; this system is linked with that of the rest of the country by a line skirting the eastern end of the range at Baku.

The sea-borne commerce of Russia suffers to some extent from the fact that its coasts are open only to Arctic waters or to inland seas, and to a greater extent from the fact that its ports on these inland seas are very few and are more or less blocked by ice during the winter. The greatest amount of trade is done by Odessa, once the great grain exit but now a general port of the Ukraine. It is only occasionally closed in the middle of a severe winter, since it is in the south and farther west than other Black Sea ports and also its harbour is not at a river mouth but on the sea itself. Judged by the amount of trade, Leningrad ranks as the second port of Russia, but the Neva is blocked for about

five months in the year. From Leningrad a railway goes northward across the mineral-bearing Kola Peninsula to Murmansk, which the Gulf Stream Drift keeps open, aided by ice-breakers. Archangel, situated where the Northern Dvina empties its waters into the White Sea, is closed for more than half the year.

Gorky (Nizhni Novgorod), where the Oka joins the Volga, is one of the textile, metal, and wood-working towns of the central industrial region. Other important inland centres are Kiev, on the Dnieper, the capital of the Ukraine, and Kharkov.

The foreign trade of Russia has considerably changed its character, for grain and other food materials are needed at home for the growing industrial population, and are no longer sent abroad; the chief exports are timber; furs, skins and leather; minerals (including oil) and mineral products; flax. The imports are largely connected with the industries, consisting either of machinery and apparatus or of certain raw materials, e.g. rubber.

Russia has such a wide range of natural resources that it is almost self-sufficient, and for political reasons also its commerce with other countries is relatively small.

IBERIAN PENINSULA

Natural Regions.—*Western Marginal Highlands:* The southern slopes of the Pyrenees (C^1); North-western Spain (C^2). *Transition Region:* South-western margin of the Iberian Peninsula (C-D). *Mediterranean Regions:* Western margin of the Mediterranean Sea with the Ebro Valley (D^1). *The Iberian Plateau* (E).

Historical and Political Survey.—The people of Spain and Portugal are of the Mediterranean Race, for the Moorish intrusions brought to the Peninsula people of the same race as the inhabitants, though differing from them in religion and nationality, and earlier intrusions of Alpine and Northern (Gothic) peoples have left comparatively few traces.

The reconquest of Spain from the Moors was gradual and led to the establishment of separate kingdoms. In the mountainous north alone the Christians retained their independence and here arose the states of Galicia, the Asturias and Navarre. From the north-west a reconquest took place southward, and on

this was based the kingdom of Portugal. Farther east the Ebro basin was recovered and formed the kingdom of Aragon. Similarly Old Castile (the "Castle" land) was formed, extending from the coast as far south as the Sierra de Guadarrama, New Castile reached to the Sierra Morena, while Leon was formed west of Old Castile. The union of Leon and Castile and afterwards that of Castile and Aragon gave the Spaniards sufficient power to expel the Moors even from their stronghold of Granada in the Sierra Nevada mountains, and gradually all the eastern states were incorporated into the kingdom of Spain.

The sea-girt position of the peninsula aided the maritime importance of Spain and Portugal, and the sailors of both countries made most important discoveries, e.g. Columbus, although a Genoese, sailed from Spain and discovered the New World in 1492, the Portuguese admiral Vasco da Gama sailed round Africa to India in 1498, and Magellan, another Portuguese, sailed round the world in the interest of the King of Spain in the years 1519-22. By that time the Pope had divided all newly discovered lands between the Spanish and Portuguese sovereigns. This led to great oversea settlements and possessions, but most of these have since been lost; Spain now retains little save the adjacent islands of the Canaries and the Balearic Isles, but Portugal possesses the Cape Verde Islands, Angola in West Africa, and Mozambique in East Africa, besides some smaller territories.

The capital of Portugal is Lisbon on the estuary of the Tagus, in all respects the most important city of this country, with about half-a-million inhabitants. The capital of Spain is Madrid, chosen because of its central position and having little else to favour its development; nevertheless, Madrid has become the centre of routes in Spain and has a population of about a million persons.

The area of the whole peninsula is rather less than twice that of Britain; but the natural resources are not great and a lack of energy has characterized many of the people, so that the whole land only supports a population rather more than half as numerous as that of Britain, namely, about 26,000,000 in Spain and 7,000,000 in Portugal.

The rocky peninsula of Gibraltar, "the key of the Mediter-

ranean," is a strongly-fortified British naval station and fueling station, corresponding in these respects with the rocky island of Malta (capital, Valetta) south of Sicily.

Agriculture.—Although the people of the Peninsula are mainly dependent on the produce of the soil, at least one quarter of the ground is quite unproductive. This is due in part to the mountainous character of the land, more largely to the lack of water in many parts, and to some extent to the inadequate use the people make of the possibilities afforded by nature.

Another quarter of the land is used only for pasture. Much of the tableland is of this character, and in the interior the pasture is very poor. Among the animals, sheep are by far the most numerous, and for two or three centuries Spanish wool had an importance and a reputation now lost. The Portuguese portion being better watered has more useful pasture-lands, and this is true also of the northern coastal regions; consequently in these districts both sheep and cattle are kept to a considerable extent. The oak woods of the south afford food for many pigs.

Forests do not cover a large proportion of the country; in the northern highlands they are similar to those of Central Europe and only in the southern portion of the peninsula are they of the Mediterranean type. The cork oak is an important tree of this type, growing more abundantly in the moister west and hence obtained in greater quantities from Portugal than from Spain.

Less than half the land, therefore, is cultivated. Cereals occupy the largest part of this area, and among them wheat and barley are predominant, rye, oats and maize being relatively unimportant; the wheat is grown largely on the plateau, especially in the valleys of the Douro and the Tagus. The vine is cultivated in the valleys of all the larger rivers, along the southern and eastern coasts, and on the lower slopes of the Pyrenees. The olive is found where there is the true "Mediterranean" climate of a mild winter as well as a dry summer, *i.e.* in the lower areas of the south. The fertile plain of Andalusia, warm and open to the moisture-bearing winds, is an important agricultural region.

In the dry south-east of the country irrigation with water brought by the rivers from the mountains is important, for the

heat is favourable to the growth of many crops and particularly of fruit. This irrigation, largely a legacy of the Moorish occupation, is carried on in Valencia, Murcia, and Granada, where the huertas (gardens) yield besides cereals, fruits such as oranges, lemons, pomegranates, figs and almonds in abundance, and occasionally even rice, the sugar-cane, and cotton. The thorough and careful cultivation of these huertas, which may yield crop after crop in one year, is in striking contrast with the poverty of a large part of the plateau area.

Minerals and Manufacture.—The Iberian Peninsula is very rich in minerals. Of these iron ore is obtained in the greatest quantities, the most important districts being in the Cantabrian Mountains and especially behind the ports Bilbao and Santander, and also in the Sierra Nevada, and particularly in Murcia. Lead and silver, in places extracted from the same ore, are found in the Sierra Morena and the east of the Sierra Nevada. Copper, often found with iron, is mined in greater quantities in this peninsula than in any other part of Europe; it is obtained in the south-west corner of the Meseta, mainly in Spain near the Rio Tinto, but also in Portugal. Coal exists in considerable amounts, but the coalfields are scattered and largely undeveloped; the chief mining takes place in the Asturias portion of the Cantabrian Mountains. Other minerals are zinc, quicksilver from the famous mines at Almaden in the south of the Meseta, and salt, which is obtained both by evaporation around the southern coasts and by quarrying in the northern mountains.

The manufactures have been developed to a less extent than this mineral wealth would indicate. The most important region is situated around Barcelona in Catalonia; this city is the chief port of Spain and approximately equal to Madrid in size. Here the manufacture of textiles, especially cottons, is carried on, not because of the local production of rawmaterials but to some extent on account of the facilities for transport by sea; a still more important factor is the exceptional industry of the people, who, it may be observed, are descended from exceptionally mixed ancestry. Increasing use is being made of the water power of the Pyrenees.

The only other important industry is that of the Basque Provinces, where iron is smelted and manufactured from local ore,

by means of imported coal and water power from the mountain streams.

Communications and Commerce.—Since the productive portions of the peninsula lie either around the coasts or in the river valleys, communication by water, either by sea or by river, tends to be of greater importance than that by road or railway. Further, because of the peninsular position there are no great continental routes running through the country. Hence the railroads have merely local importance and the only great railway centre is Madrid.

The largest towns, with the single exception of the capital of Spain, are therefore either on the coast or on navigable rivers. In Portugal the capital is on the estuary of the Tagus, which is navigable almost to the Spanish boundary. The next largest city is Oporto, whence "port" wine is shipped. It stands at the mouth of the Douro, navigable to where its gorge-like valley forms the frontier. The Guadalquivir has Seville, which exports Seville oranges among other products, at the head of navigation for large vessels. Just south of the mouth of this river is Cadiz, another wine-exporting city, and corresponding to this in many ways is Malaga on the Mediterranean coast. Valencia is a still larger Mediterranean port, but Murcia and Zaragoza (Saragossa) are essentially the local market-towns of agricultural districts, though the Ebro is navigable for small boats far beyond Zaragoza.

The chief imports are those of a non-manufacturing region, including steel goods and coal; the exports well express the natural resources, being ores of iron, lead, mercury and copper, besides fruit, early vegetables, cork, olive oil and wine.

ITALY

Natural Regions.—*Central Highlands:* Portions of the Alps (K^{10}). *The N. Italian or Lombardy Plain* (F). *Mediterranean Regions:* Part of the North-western margin (D^2); The Peninsula and Sicily (D^2); Sardinia (D^4).

Historical and Political Survey.—The Mediterranean Race has been superseded in the northern portions of the country by the Alpine Race, and there remain indications of the incursions to the Northern Race in the people as well as in the name of Lombardy. The power of Rome early unified Italy, but after

the decline of the Roman Empire there arose a number of small states, including the Papal States around Rome and great city-republics such as Venice and Genoa.

During this period Rome remained the seat of the Popes and retained its importance as the chief spiritual centre of Christendom. For many centuries there were struggles between the various Italian powers as well as partial conquests by northern nations, but in 1860 several states united and the King of Sardinia was chosen King of Italy with the seat of government at Florence. This union was completed in 1870, when all Italy came under one rule and Rome, "the Eternal City," again became the political capital, a position to which it is entitled no less by its central situation than by its historical pre-eminence. The population of Rome is now about one million persons.

After the war of 1914-18 Austria ceded to Italy all the region drained by the Adige, including the Italian-speaking Trentino, and the eastern shores of the Gulf of Venice, including Trieste and Fiume.

The area of Italy is somewhat less than that of the British Isles, and the population is about 44,000,000; hence it is rather densely populated and is almost exactly comparable to Germany in this respect. There is now little emigration, as the internal resources of the country have been recently utilised more fully than before.

Agriculture.—The dense population of Italy is supported largely by agriculture, which must therefore be much more productive than that of Spain. The rainfall of Italy is greater than the rainfall of Spain and is more evenly distributed, while the temperature conditions are very similar. In Italy, moreover, there is a larger proportion of lowland, and irrigation is even more extensively practised, especially in the plain of Lombardy which has not the "Mediterranean" summer drought, and also gets water from the rains and snows of the surrounding mountains.

About nine-tenths of the land may be classed as productive, and of this corn crops occupy the greatest area. Wheat is far more important than any other of these crops as it is grown in all parts except the higher mountain ridges; maize ranks second among the cereals and is grown especially on the northern plain, which in this and other ways is similar to the plain of Hungary;

rice is another valuable crop, obtained from the irrigated lands of the north. Hemp and beet-root are also noteworthy.

Grass-land comes next to corn crops in regard to the extent of land covered, and the meadows which are irrigated for this purpose bear several rich crops each year. Sheep and cattle are both numerous, and cheese is an important product.

The vineyards occupy a greater area than in any other country in the world, though the amount of wine obtained is second to that of France. The vine is cultivated over much of the northern plain and a large part of the coastal regions of the south. The olive yards are extensive on the hill-slopes of the peninsular portion, and Italy produces more olive oil than any other country. In the production of raw silk Italy is first among the countries of Europe; a decline in its production accompanies the development of artificial silk (rayon) which Italy manufactures in great amounts, often mixed with real silk. Oranges, lemons, figs and other "Mediterranean" fruits are obtained from the southern portion of the peninsula. These fruits, together with vines, olives, and wheat, are grown also in the islands of Sicily, Sardinia, and Corsica, the last named belonging politically to France.

The fertility of the alluvial northern plain is shown by the fact that the vine is trained on mulberry trees, and beneath them maize, rice or wheat is grown, so that food, drink and clothing (silk) are all supplied from the same soil.

Minerals and Manufactures.—The poverty of Italy in respect of minerals is another point of contrast between this country and the Iberian Peninsula. On the mainland little mining is carried on, but there are famous marble quarries near Carrara in the northern Apennines, and quicksilver and bauxite are obtained further south. From the islands come the sulphur of Sicily, the iron of Elba, and zinc, lead and iron from Sardinia.

As a consequence of the lack of coal and other minerals, manufactures have only lately attained importance, and this growth is largely because the increased population cannot be provided with a corresponding increase in work by means of agriculture alone. Hence labour has become abundant and cheap and efforts have been made to raise Italy to a high rank among industrial countries. Also the large population supplies a market

for the manufactured goods. Mechanical power is obtained from imported coal and oil, but recently great developments have taken place in the use of water power from the Alps and the Apennines. The chief manufactures (silk, rayon, and cotton goods, machinery and motor cars, rubber goods, chemicals, etc.) are in the north, with Milan and Turin as the largest centres.

Communications and Commerce.—The peninsular character of the country and the mountain barriers of the north tend to cause the foreign trade to be carried on by sea rather than by land. The great ports of the north are Genoa, situated at the head of the Gulf of Genoa where the low Bocchetta Pass gives comparatively easy access to the northern plain, and Venice, which stands at the head of the Adriatic Sea and is built upon islands north of the delta of the Po. The age-long importance of these cities has been largely due to the fact that they are also at the commencement of land routes from the Mediterranean Sea to Northern Europe. In six directions railway lines now lead from northern Italy across the Alps. From Turin, where the Dora Riparia joins the Po, the route leads westward by the Mont Cenis tunnel; from Milan, the great centre of the plain and in size about the equal of Rome, there are two routes, one leading north-westward by the Simplon tunnel and one northward by the St. Gotthard tunnel; from Verona a line leads northward over the Brenner Pass; from Venice and from Trieste there are several routes to the north-east over the Semmering Pass to Vienna.

In peninsular Italy the great railway routes skirt the coasts. On the eastern side the main line passes along the southern border of the plain through Bologna, whence another route crosses the Apennines to Florence. The express overland route to the East continues by the east coast to Brindisi, where the steamers which have come around Spain call for passengers and mails. On the western side of the Apennines there is a similar coastal road, and in Central Italy an important route leads up the Arno valley from Florence, famous for its art treasures, and down the Tiber valley to Rome. Farther south is Naples, the third city of Italy, built in a beautiful situation on the Bay of Naples. Florence, Rome, and Naples all owe a part of their growth to the fact that they are centres of very fertile lowland areas.

The three ports of Sicily, viz. Palermo, Messina and Catania, also rank among the large cities of the kingdom.

The population of Italy is so great that wheat has to be imported, in addition to raw cotton, iron and steel goods, oil, and coal. The chief exports are goods of cotton, silk, and artificial silk, fruit and vegetables, and motor-cars.

RUMANIA

Natural Regions.—*European Steppes:* Northern part of the Lower Danube Plain (N^2); western end of the South Russian Plain (N^1). *Central Highlands:* Southern part of the Carpathian and Transylvanian Region (K^{12}). *The Hungarian Plains:* South-eastern part of the Lower Plain (L^2).

The Rumanians are of mixed race, with both Slavonic and Asiatic elements, and speak a language derived from Latin. Before the Great War some of their kinsmen lived under Russians in Bessarabia and under Magyars in Transylvania and its western borders; hence they seized these lands so that their country is now nearly as large as the British Isles. The population is about 20,000,000, including many Russians and Magyars, and even descendants of German settlers.

The Transylvanian and Carpathian mountains divide the country into two markedly contrasted areas. To the north-west is the high basin of Transylvania, partly drained westward to the River Tisza and partly southward by the River Aluta (Oltu) through the Transylvanian Alps. The basin is largely forested, has iron deposits and a little gold and silver in the highlands of its western rim, and in the valleys and along the western boundary agriculture and the growing of vines are carried on.

The resources of the north-western region, however, do not support so great a population as the fertile plains of the south-eastern region. Here the Aluta and the rivers from the Transylvanian Alps flow southward to the Danube over the Plain of Walachia, the Seret and Prut drain Moldavia, and this adjoins Bessarabia west of the Dneister. These are rich lands which yield great crops of maize and wheat and less barley and oats. On these plains cattle and sheep are kept. Petroleum is obtained along the strip of country between the mountains and the plains,

especially north of Bucharest, and salt also from the edge of the highland region. The chief exports are grain, timber, petroleum, and live-stock.

Another asset of Rumania is its possession of the mouths of the Danube, where are the river-ports of Braila and Galatz and the seaport Sulina. The capital, Bucharest, has about 700,000 inhabitants. It stands in the Walachian Plain where the east-west railway meets the eastern line from Transylvania ; the more western railway joining the two parts of the state follows the Aluta valley through the Red Tower Pass.

YUGOSLAVIA

Natural Regions.—*Central Highlands :* The eastern end of the Southern Alps (K^{10}) ; the western part of the North Balkan Highlands (K^{13}). *The Hungarian Plains :* The southern edge of the Lower Plain (L^2). *The Mediterranean Regions :* The northern part of the West Balkan Slopes (D^5).

The State of Yugoslavia[1] is also known as the kingdom of the Serbs, Croats and Slovenes : the Serbs are mainly in the east, Croats in the centre, and Slovenes north of the Istrian peninsula. They are closely akin and have accepted the rule of the King of Serbia. Together they number about 16,000,000 people, and their country is nearly as large as Rumania.

The coast of the Adriatic has abundant harbourage, but the country immediately behind is mountainous and has no resources save some pasturage and forests, while routes through this strip to the more valuable lands behind are few and difficult. Apart from the route from the Upper Sava to Susak, the easiest is that by the Bosna and Neretva (Narenta) Rivers past Sarajevo.

With the exception of the Macedonian region of the Upper Vardar, the most productive part of the country drains to the Danube. Particularly useful are the valleys of the Drava and Sava with the land between them, and in the valley of the Sava are the towns Ljubjana (Laibach) and Zagreb (Agram), while at its junction with the Danube is the capital, Belgrade, which has a population of 300,000 people. The products of these lowland areas are maize, wheat and cattle, while the more mountainous

[1] Sometimes printed as Yugo-Slavia and Jugo-Slavia.

parts bear forests, largely of beech and oak. The Morava valley, in addition to being fertile, forms the northern part of the great roads from Europe through the Balkan Peninsula. Where the River Nishava enters the Morava (by the town of Nish) one route branches off up the valley of this tributary to Bulgaria and Istanbul, while the other route continues up the main valley and across a low watershed to the Vardar valley by Uskub and so to the Ægean Sea at Salonika (Thessaloniki).

ALBANIA

Behind a coastal lowland this mountainous country occupies the central part of the West Balkan Mediterranean Region. The Albanians, numbering about one million, are hill-shepherds who also grow maize, barley and fruit. Recent developments include the drainage of the coastal marshes and the exploitation of oil, exported to Italy. The capital is the small town of Tirana. In 1939, Albania was annexed by Italy.

BULGARIA

Natural Regions.—*The European Steppe :* Northern part of the Lower Danube Plain (N^2). *Central Highlands :* Eastern part of the North Balkan Highlands (K^{13}). *Mediterranean Regions :* North-east corner of the East Balkan Region (D^6).

The Bulgarian people are of mixed Bulgar (Ugro-Finn) and Slavonic Race ; they number about 6,000,000 people and their country is about as large as Scotland and Wales together. Much of the land is mountainous, and forested with beech, oak and coniferous trees. The more valuable parts are the Plovdiv (Philippopolis) Basin, the plains south of the Danube, and the high Sofia Basin. Wheat and maize are the chief crops ; large numbers of sheep, cattle and pigs are kept, and fruit (particularly plums dried and sold as prunes) is widely grown.

The great land route between Europe and the East passes up the Nishava valley into the Sofia Basin, and then down the Maritza valley through the Plovdiv Basin ; thence it goes out of Bulgarian territory and by Edirne (Adrianople) in the lower Maritza Basin to Istanbul. In addition to this railway route which passes through Sofia, the capital, roads lead from this city northward by the Isker valley to the Danube and southward by

the Struma valley to the Ægean Sea. As all the large rivers of Bulgaria flow through other countries before reaching the sea, Bulgaria possesses only the small ports Varna and Burgas.

GREECE

Natural Regions.—*Mediterranean Regions*: The southern part of the West Balkan Region (D^5); the great part of the East Balkan Region (D^6). Also the Ægean islands and Crete.

The Greeks have spread from the south of the Balkan Peninsula to all the islands and shores of the Ægean Sea, following their typical occupations of growing fruit on the plains and hill-sides facing the sea and trading in the products of this work and other commodities. They have kept their language (handed down from the ancient Greeks), their traditions and religion, and their feeling of a common nationality. The area of Greece is equal to that of England, and the population is about 7,000,000.

The uplands which occupy much of the country afford grazing to large flocks of sheep and goats. The cereal crops are mainly wheat and barley; vines, olives and figs are the most important fruits; wine, tobacco, currants and raisins, and olive oil are the commercial products. Athens, the capital, and its port Piræus together have a population of over half a million; Salonica (Thessaloniki), which deals with Yugoslav commerce to the Ægean Sea, as well as local Greek trade, is the next largest city.

TURKEY

European Turkey is now reduced to the Edirne Basin, and the capital, Ankara, is in Asia Minor. Istanbul (formerly Constantinople) is the crossing-point of the land route between Europe and Southern Asia and the water route between the Mediterranean and Black Seas; its population is about one million.

Authorities and Books for Further Reading.

Géographie Universelle, Tomes 2-7 (Paris: Colin).
A. Philippson: *Europa* (Leipzig: Bibliographisches Institut).
J. F. Unstead: *Europe* (University of London Press).
M. R. Shackleton, *Europe* (Longmans).
I. Bowman: *The New World* (Harrap).
M. I. Newbigin: *Southern Europe* (Methuen).
H. Ormsby: *France* (Methuen).

CHAPTER XXIV

ASIA—PHYSICAL CONDITIONS

Asia is the largest of the continents, covering an area of 17,000,000 square miles, and stretching from within thirteen degrees of the pole to within one degree of the equator. On the north, south and east it has water boundaries, the Arctic, Indian and Pacific Oceans respectively; on the west it has land connexion with Europe and North Africa, and prolongs eastward many of the characteristics of the structure, relief, climate and vegetation of these two continents.

RELIEF, STRUCTURE AND DRAINAGE

As regards the broad outlines of relief, Asia falls into five contrasting divisions: (1) the north-western plains, (2) the central highlands, (3) the south-western plateaus, (4) the eastern margins, (5) the southern peninsulas.

The Plains of the West and North.—The Ural Mountains do not form any formidable barrier between the Russian plains and those of Siberia, while the Caspian lowlands are continuous with those around the Aral Sea. These plains consist of vast stretches of undisturbed and unfolded sedimentary rocks; those of Western Siberia are low, and so level that the land is badly drained, swamps are numerous, and the rivers, of which the Ob is the chief, are unable to carry away their loads of silt, much of the area being therefore covered with deposits of alluvium. Farther east the plains gradually become narrower as the highlands to the south of them extend farther north; here the surface is somewhat higher and less uniform than farther west, while the sedimentary rocks are of much greater age. This eastern area is drained by the rivers Yenesei and Lena, which, like the Ob, flow into the Arctic Ocean. The south-western plains form an inland drainage area, and slope down towards

the shores of the salt Aral Sea, which receives the waters of the Syr Daria and Amu Daria.

The Central Highlands consist of a series of lofty mountain chains, with a general trend from west to east, between which lie elevated basins and plateaus. In the northern part of this region the main lines of relief have been determined by a series of fractures in the Earth's crust, followed by the uplift of some crustal blocks and the subsidence of others. Such uplifted blocks, deeply eroded by rivers, form the Altai, Sayan, and Yablonoi Mountains. The Khingan Mountains, which form the eastern border of the highlands, consist of a block so tilted as to present a steep face seawards, and a gentle slope towards the interior ; somewhat similar features are presented by the Stanovoi Mountains farther to the north. Baikal, a large fresh-water lake drained by a tributary of the Yenesei, occupies a deep rift-valley formed by the subsidence of a narrow crustal block.

South of this fractured region there is a vast system of folded mountains similar in structure to the Alps. The principal chains radiate from the Pamirs, " the Roof of the World " ; they are the Tian Shan, the Kuen Lun, the Karakorum and the Himalaya Mountains. The last-named range is the best known ; it consists of a number of parallel ridges, one of which, formed of ancient crystalline rocks, includes a series of lofty peaks, among them Mount Everest, which is 29,000 feet or $5\frac{1}{2}$ miles high. Between the Tian Shan and Kuen Lun ranges lies the Tarim basin, across which the Tarim river flows with a dwindling volume, and finally spreads out into the marshes of Lob Nor. To the north-east lies the Gobi basin, separated into two parts by a transverse mountain range. Between the Kuen Lun and the Himalayas lies the plateau of Tibet, which has a general altitude of over 12,000 feet ; it does not present a level surface, but is crossed by a series of mountain chains, between which lie numerous lake basins. Although the drainage of much of the central highland region has no outlet to the sea, yet a large number of the great rivers of Asia have their head waters well within its borders. The Indus and its chief tributary the Sutlej take their rise behind the main chain of the Himalayas, which they cross by means of magnificent gorges, while the general direction

of the upper Indus valley is prolonged by that of the San-pu, which after flowing eastward also breaks through the Himalayas and, under the name of the Brahmaputra, joins the Ganges. It is probable that the mountains were uplifted so slowly that these rivers were able to maintain their original courses from north to south across them by progressively deepening their valleys, and that the longitudinal valleys parallel to the axis of the chain were worn out later along the line of outcrop of some relatively unresistant rock.

The Western Plateaus.—The fold-mountain system may also be traced westwards from the Pamirs; the Hindu Kush and the Sulaiman Range, with the Elburz and Zagros Mountains (the latter overlooking Mesopotamia) are the chief of the ranges enclosing the plateau of Iran, which is an inland drainage area. The two last-named chains converge on the lofty volcanic highlands of Armenia, whence the Pontic Ranges and the Taurus Mountains, the former overlooking the Black Sea and the latter the Mediterranean Sea, diverge so as to enclose the plateau of Asia Minor. Only the narrow straits of Bosporus and the Dardanelles separate this region from the Balkan peninsula, in which the same fold-mountain system is continued.

The Eastern Margins.—These are remarkable for the series of loops or curves, convex to the east, which can be traced both in the coast-line and in the bordering islands, and are also repeated by the edges of the Stanovoi and Khingan tilted blocks. The true Pacific border is formed by the Kamchatka peninsula, the Kurile Islands, Japan, the Lu Chu Islands, and the Philippine group; on all of these there are active and extinct volcanoes, of which Fuji-san in Japan is the most famous; the region is also subject to earthquakes. Within this border lies a series of enclosed seas, the Seas of Okhotsk and Japan, the Yellow and East China Seas, and the South China Sea, all of which occupy basins due to the subsidence of crustal blocks. This eastern region is drained by the Amur, the Hwang-ho, and the Yangtse-kiang, which take their rise far within the central highlands, whence they descend by a series of rapids. The first and the last named are navigable for long distances from their mouths. The Hwang-ho has built up a great alluvial plain, over which its

course is very uncertain ; within the last century it found its way to the Yellow Sea by a mouth to the south of the Shantung peninsula, instead of entering the Gulf of Pechili, as at the present day. The Tsin-ling Mountains, bordered by the parallel valleys of the Wei-ho and Han-ho, form an easterly prolongation of the Kuen Lun chain, and were possibly once continuous with the Mountains of Japan. To the south of the Yangtse-kiang lies an upland region with a very indented coast-line where the mountains have been carved out by erosion from a mass of very ancient rocks ; here the principal lowland is the valley of the Si-kiang. The mountainous island of Formosa forms part of this region.

The Southern Peninsulas.—Arabia is a tableland formed mainly of horizontal sedimentary rocks similar to those of the great African tableland, from which it is only separated by the deep, narrow rift valley containing the Red Sea. This valley is prolonged into Syria, where it contains the Jordan and the Dead Sea. The Arabian tableland is tilted, so that it presents steep borders to the west and south, while sloping gradually towards the Persian Gulf and Mesopotamia. It has neither lakes nor perennial rivers, except for some small streams in the south-west. The Persian Gulf once extended much farther to the north-west, but it has been gradually filled by the alluvium brought down by the Euphrates and Tigris from the highlands of Armenia and Kurdistan.

The Dekkan, the peninsular portion of India, is also a tableland built of rocks which have long been undisturbed ; it presents towards the Arabian Sea a very steep border or escarpment, which is known as the Western Ghats. Its eastern margin is less well marked, and here a geologically recent change of sea-level has caused the addition of a marginal belt of younger sediments, which form a coastal plain. A chain of rocky islands, known as Adam's Bridge, bears witness to a former land connexion between India and Ceylon. The general slope of the tableland eastward causes most of the rivers, for example the Godavari and Kistna, to flow in this direction. Among the exceptions is the Narbada, which has cut a rocky gorge in the western margin and descends it by a series of rapids. The Dekkan is separated from the folded mountain system to the north by the extensive alluvial plains

drained and partly built up by the Indus and the Ganges, both of which rivers are still enlarging their immense deltas.

In Indo-China, which forms the third peninsula, the mountain chains and rivers run from north to south. It is probable that the change from the west to east direction of the folded mountains of Central Asia was due to the resistant blocks of old rock found in Southern China and Siam, against which the folds were pressed. The coast of Annam has the same convex curve as those of China and Korea, and the bordering mountains rise up steeply from it, but slope more gradually towards the interior. The rivers of this region, notably the Irawadi and Mekong, bring down great quantities of silt from the highlands, and have built up very large deltas. The parallel chains of Burma are continued in the Andaman Islands and the Malay peninsula, and in Sumatra, Java and the Lesser Sunda Islands, where they resume an easterly direction. On all these islands there are numerous volanoes; Krakatoa, in the Strait of Sunda, was violently active in 1883.

CLIMATE

In the extreme north of Asia the climate is similar to that of the Arctic lowlands of Europe and North America. The winters are long, dark, and very cold, the summers short and cool, the precipitation is small and occurs mainly as snow. Farther south lies a belt with warm summers, exceedingly severe winters and a moderate summer rainfall; here the climate is similar to that of north-eastern Russia, except that the winter cold is more intense, and the temperature range correspondingly greater. Farther to the south-west the plains have a much hotter summer, a cold winter and a low rainfall. In the central highlands there is little precipitation except on the marginal mountain ranges, many of which have their summits above the snow-line, and all of which are snow-clad in winter. In the dry basins and plateaus which they enclose, the absence of clouds leads to very intense insolation and rapid radiation, so that the days are hot and the nights cold. Where the altitude is great, as in Tibet and the Pamirs, this effect is intensified by the rarity of the air, and in particular radiation is very rapid, so that although the sun is hot, the mean daily and annual temperatures are very low.

The western plateaus, owing to their lower latitude and their lower elevation, have much less severe winters than the central highlands. They form an extension of the Mediterranean region of summer drought, the precipitation occurring chiefly in winter and spring. It is fairly abundant on the borders of Asia Minor, but diminishes in the interior basins, and is especially low in Iran, where in consequence the summer heat is very great. Arabia is an extension of the almost rainless Sahara: it lies between the winter cyclonic rain belt and the belt of summer tropical rains; only in the highlands of the south-west, as in the neighbouring highlands of Abyssinia, is there a regular rainfall. In Arabia, as in all the hot arid regions of Asia, convection currents are set up in still weather, producing whirling dust-storms which sweep across the desert.

In the remainder of southern and eastern Asia the climate is determined by the monsoon wind system (see p. 103). In India the inflow of air in summer and the outflow in winter is confined to the area south of the Himalayas; this great rampart prevents the warm moist winds from reaching Tibet, and also shelters India from cold blasts from the plateau in winter. The summer monsoon is an extension of the south-east trade winds, which cross the equator and are then deflected to the right, becoming south-west winds. By July the system is fully established over India, the winds being generally south-west over the Dekkan, south over the Ganges delta, and south-east up the Ganges valley. The Indus basin is the last area reached by these winds, and the first from which they retreat, so that here the yearly rainfall is very low. It is heaviest on the Western Ghats, the Himalayas and in Burma, where it is accentuated by the relief of the land. In eastern Asia the strength of the summer monsoon, and in consequence the amount of rainfall, diminishes as the latitude increases, while at the same time the strength of the winter monsoon increases. The northerly winter monsoon produces very low temperatures as far south as the North China plain, and the ports round the Gulf of Pechili are closed by ice in winter. Throughout the extra-tropical regions cyclonic storms coming from the west bring some rain in winter and spring. In summer violent typhoons are generated in the South China Sea, and move

in a northerly direction towards Japan, while at the change of the monsoon tropical cyclones, equally destructive, arise in the Bay of Bengal and the Arabian Sea. The groups of islands to the south-east of Asia have a uniformly high temperature, owing to their position near the equator, and rain at all seasons, being swept alternately by the winds drawn towards Asia and those drawn towards Australia.

RÉGIME OF THE RIVERS

The rivers of the northern plain are ice-bound during the long winter, and as their mouths remain frozen after the upper courses have been freed, there are great floods in the spring. The Amur also is frozen during the winter, and is highest when the ice breaks up and the snow melts in spring. Rivers like the Syr Daria, Amu Daria, Euphrates and Tigris, which flow through almost rainless regions and are fed entirely by the mountain snows, become swollen in spring and early summer, when they flood their banks or fill the irrigation channels.

Throughout the arid basins and plateaus the bordering snow-capped mountains give rise to numerous streams which are almost dry in winter, but in summer supply water to numerous oases before becoming lost in the sands. The larger rivers of the monsoon area are supplied both by the melting snows and the summer rains, and hence show a considerable difference of volume in summer and in winter. The Hwang-ho floods its banks for miles, but the Yangtse-kiang and the Mekong are regulated by lakes, such as the Tung-ting and Tonlé Sap, which respectively receive the surplus waters of these two rivers. The flood waters of the Ganges and the Indus, especially of the latter, are drawn off into irrigation canals.

SOILS

Asia has a large number of important rivers which periodically flood their banks, and so have built up extensive flood plains and deltas of fertile alluvium. Throughout the highlands, too, and round their margins, there are numerous smaller alluvial plains, basins and valleys, such as the Vale of Kashmir in the Himalayas, and the Ferghana basin in the upper course of the Syr Daria.

In the arid regions the alternation of hot days and cold nights leads to a very rapid disintegration of the rocks, and owing to the absence of running water great accumulations of rock waste result, so that the valleys become filled up and the mountains are almost burried under their own débris. Powerful winds sweep away the lighter particles, and in many places, notably Gobi, the Tarim basin, northern and southern Arabia, and the borders of the Aral Sea, there are great stretches of shifting sand. Large deposits of fertile loess are found on the north-eastern and north-western borders of the Central Highlands, those of Northern China being the most famous. In many of the western valleys the loess is mixed with humus, and forms a rich black earth similar to that of Southern Russia. Valuable volcanic soils occur in Japan, Java and south-west Arabia, while over the whole of the north-western Dekkan there is a great sheet of old volcanic rock which has weathered to a fertile soil remarkable for its power of retaining moisture when other soils are parched and dry. Among other soils of local origin the "red earth" of Central China, formed by the weathering of an old red sandstone, is important.

VEGETATION AND ANIMALS

The extra-tropical vegetation regions continue those of Europe (see Fig. 95). In the north the treeless tundra is gradually replaced southward by the coniferous forest, which in Siberia is dense and is known as the taiga. It shelters valuable fur-bearing animals, such as the sable, mink, ermine, fox and squirrel. Towards the south the forest is replaced by grassy steppes, which occur partly on the plains, and partly within and along the borders of the central highlands, where they are more broken. In the Amur basin the larch, birch and Siberian pine of the coniferous forest are gradually replaced by the oak, elm, maple, and other deciduous trees, and in southern China the appearance of the mulberry, camellia, magnolia, bamboo and palm mark the transition to the tropical forest. The hot, wet monsoon countries are densely forested in the regions of most abundant rainfall, while elsewhere there is a savannah or jungle, varying in richness according to soil and situation, and characterized by the abundant animal life which it shelters. Among forest trees the sal and teak

are important, the bamboo grows everywhere, and the coconut palm is found near the coasts, which are often fringed with mangrove swamps. A vegetation similar to that of the Mediterranean region in Europe is found on the fertile plains and valleys which border the plateau of Asia Minor, and also in Syria. Throughout central and south-western Asia, owing to the insufficient rainfall, there is a great development of semi-desert vegetation. Hardy drought-resisting shrubs and coarse grasses growing thinly or in scattered clumps are characteristic, but much of the soil is bare. Only along the river and stream sides and by the lakes is there a richer green, due to reed swamps, rich meadows, or a thin belt of trees. Roaming over these thin pastures are herds of fleet-footed grazing animals, antelopes, gazelles, wild asses, and a few wild camels and wild horses. The mountains which border the central highlands and the south-western plateaus are well-wooded, many of their valleys are well-grassed, and below the snow-line there are Alpine pastures gay with flowers. Here sure-footed goats and agile wild sheep are found, and in Tibet the wild yak. Deserts practically devoid of vegetation are found in the driest regions where there are accumulations of sand, or where the soil is too saline to support plant-life.

NATURAL REGIONS

It will be found that the natural regions of Asia (see Fig. 128) repeat or continue those of neighbouring parts of Europe, Africa, and Australasia.

A. The Tundra.—This region occupies most of the land lying in the Frigid Zone; its irregular shore-line is ice-bound for the greater part of the year.

B. The Coniferous Forest.—The forest of this type extends over the plains and north-eastern highlands, and is often broken by swamps in the west. Here the great temperature range and intensely cold winters are characteristic.

C. The Treeless Plains.—1. *The steppes* form a belt of rich grass country with an excellent soil, and sufficient rainfall in summer. 2. *The Caspian-Aral region*, with its hotter summers and scantier rainfall, has a semi-desert vegetation, varied on the one hand by stretches of sandy desert, on the others by fertile

alluvial strips along the river and stream sides. The relatively fresh water lake Balkash receives part of the drainage of this region.

D. The Central Highlands.—1. *The dry basins and plateaus* resemble the last region both as to their inland drainage and their vegetation, but owing to their superior altitude they are

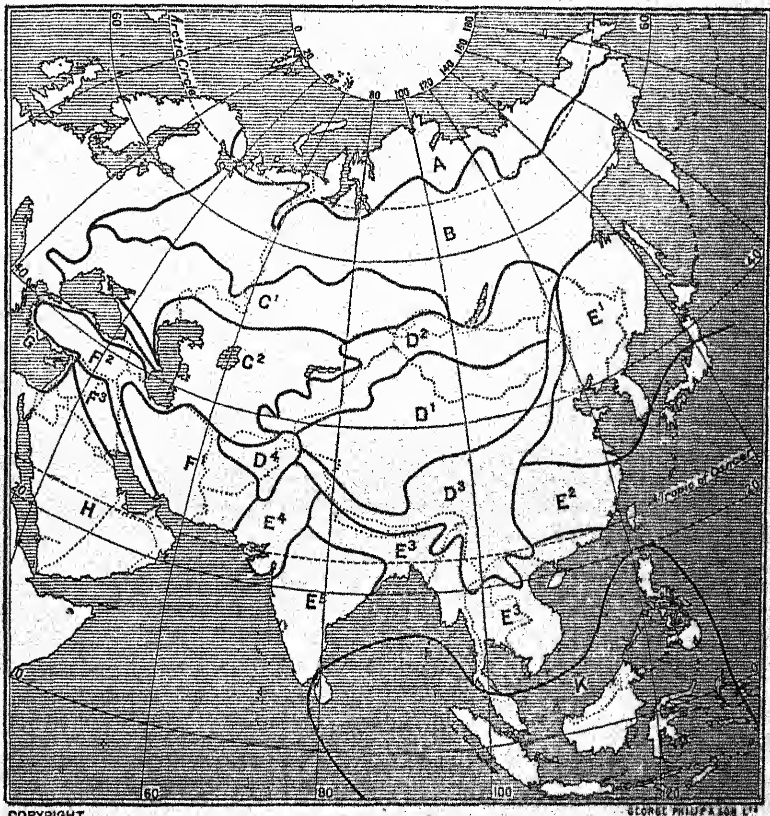


FIG. 128.—Asia. Natural Regions.

subject to more severe temperatures at night and in winter. Within the region itself, however, the differences of altitude are so great as to lead to great contrasts, such as that between the hot desert of Gobi and the cold desert of Tibet. 2, 3 and 4. *The margins of the highlands* vary in structure and altitude, but in all

there are mountain ridges separated by high or low valleys, bearing a vegetation of mountain forest and grassland. In the north the forest is coniferous, while in the warmer south and east it is deciduous on the lower slopes. The rain and snow-fall which are due to the height of the mountains feed the head-streams of the chief rivers flowing north, south, east or west across Asia. In the south-east, the broken character of the relief allows the monsoons to penetrate far inland, although the amount of rainfall soon diminishes, so that the mountain forest gives place to scrub or coarse grass on the interior ranges.

E. The Monsoon Lands.—1. *The temperate region* includes uplands and highlands clothed with mixed coniferous and deciduous forest, and the fertile plains of Manchuria and North China, which have a sufficient rainfall, cold winters and hot summers.

2. *The sub-tropical region* includes the mountainous region of Central China and Japan. In the fertile valleys and basins the winters are milder than in the region farther north, while the rainfall is everywhere more abundant and more evenly distributed through the year. 3. *The Ganges Plain and Indo-China* form a tropical region with a mean annual temperature of over 20° C. (68° F.). The rainfall is heavy except in sheltered valleys, and there are large areas of tropical forest. The Ganges plain, the Irawadi, Mekong and Song-ka deltas, and the Si-kiang valley form important fertile lowlands. 4. *The Indus plain* has an insufficient rainfall, and is clothed with acacia scrub and poor grass; it includes an area of sandy desert known as the Thar. The northern part, crossed by several rivers which feed the Indus, is the richest. Owing to the dryness the summer heat is intense. 5. *The Dekkan* lies almost entirely within the tropics, but owing to its superior elevation the heat is not so excessive as in the region just described. Dense forests clothe the western borders of the tableland and the hilly region just south of the Tropic of Cancer; elsewhere the vegetation is poorer, being a mixture of savannah and scrub.

F. The South-Western Plateaus and their Borders.—1. *Iran* is an arid region of inland drainage, with a semi-desert vegetation, except where snow-fed streams come down from the bordering mountains. The date palm is found in the extreme south,

where the mean annual temperature exceeds 20° C. 2. *The highlands of Asia Minor, Armenia and Persia* are better watered than the last-named region. The outer mountain slopes are well forested, and enclose grassy valleys, while the drier interior plains and valleys are clothed with scrub. 3. *Mesopotamia and the neighbouring plains* are the gift of the Euphrates and Tigris; near these rivers are stretches of rich alluvial soil, of which much is capable of irrigation and cultivation, and on which there are dense date groves. Elsewhere acacia scrub and coarse pasture cover the ground.

G. The Mediterranean Borders.—These include a series of fertile valleys and plains which have the mild, sunny climate and the vegetation of evergreen trees and shrubs, characteristic of the similarly situated regions of Europe.

H. Arabia.—This region is largely a hot desert area, but the northern and southern sandy or stony deserts are separated by a more hilly region, the Nejd, where the rainfall is slightly higher and a semi-desert vegetation is found, and where the valleys, though rarely containing running water, bear good pastures. In the south-west region also, where there is a rich volcanic soil, a heavier rainfall, and a temperature somewhat moderated by the altitude, the vegetation is more abundant.

K. The East Indies and Philippines.—These are tropical islands with a high temperature and abundant rainfall throughout the year. In many places they have a rich volcanic or alluvial soil. The lowlands are clothed with dense tropical forest, including many valuable palms, while on the higher ground there is a vegetation of the savannah type.

For Authorities and Books for further reading, see end of Chapter XXV.

CHAPTER XXV

ASIA—POLITICAL AND ECONOMIC CONDITIONS

RUSSIA IN ASIA

Natural Regions.—*Tundra* (A). *Coniferous Forest* (B). *Treeless Plains:* The Steppes (C^1); The Caspian-Aral Region (C^2). *Central Highlands:* Portions of the Northern Margins of the Highlands (D^2). *Monsoon Lands:* Portions of the Temperate Monsoon Region (E^{1a}).

Political and Economic Conditions.—The Russian portion of Asia occupies about 6,000,000 square miles, and therefore more than one-third of the whole area, but the population amounts only to some forty million persons, although the whole of Asia is inhabited by perhaps 1,000 million people.

The more favourable climatic conditions of the east and south are the chief cause of this disparity in population, but the resources of the more northern lands only await development to provide the means of livelihood to many times the number of people at present living in Russian Asia; the extension of facilities for transport will render available the great agricultural and mineral resources of this area.

The tundra lands yield little of commercial value except fossil ivory and some skins and furs. These latter are obtained in much greater amount from the coniferous forest region; there is practically no trade in timber from this region, owing largely to the fact that the rivers, which form the natural means of transport, run northward to the Arctic Sea.

The steppes and the southern portion of the forest land are capable of cultivation, and the former already produce considerable crops of wheat and oats, rye and potatoes also being worthy

of note. Large tracts of country are used for grazing; sheep, cattle and horses are reared in great numbers, and an export trade in dairy produce is developing.

In Russian Central Asia, the strips of irrigated land bordering the rivers and oases are valuable for their agriculture; cotton and rice are of importance; silk is another product. On an ancient trade-route between the deserts of Turkestan and the mountains of Central Asia are several large cities including Tashkent, Samarkand and Bokhara.

The very extensive mineral resources include gold, silver, copper and graphite, all obtained from the northern margins of the central highlands of Asia; the south-western portion of this region (D^2) also yields petroleum. Coal deposits lie beneath the steppes in the west, at the borders of the steppes and the central highlands, and in the eastern marginal lands north of Vladivostok.

The Trans-Siberian railway has already led to immigration and trade. The line from European Russia crosses the fertile steppes, passing through Omsk and Novosibirsk where it links up with the "Turksib" line coming from Turkestan between the steppes and the highlands. The Siberian railway continues eastward through the forest region south of Tomsk, with which it is joined by a short line, to Irkutsk near Lake Baikal. The last stage is north of the Amur river to Vladivostok, though a more direct route goes through Manchukuo. Vladivostok is the chief Pacific port of Russia, but although as far south as latitude 43°N., it suffers the disadvantage of being ice-bound for more than a month in winter, a passage being kept open by ice-breakers.

Two railway routes, besides the "Turksib," penetrate Russian Central Asia: the Trans-Caspian railway passes from the Caspian Sea through Merv and Samarkand to Khokand; the other crosses from Europe south of the Ural Mountains, skirts the Sea of Aral, and proceeds up the valley of the Syr Daria to Tashkent, the largest city of the Central Asian Republics.

The northern half of the island of Sakhalin is Russian; the southern half belongs to Japan.

CHINESE STATES

Natural Regions.—*Central Highlands:* The Dry Basins and Plateaus (D^1); Portions of the Northern Margins (D^2);

Portions of the Eastern Margins (D^3). *Monsoon Lands:* The southern portion of the Temperate Monsoon Region (E^{1b}, E^{1c}); The Subtropical Monsoon Region (E^2); the northern portion of the Tropical Monsoon Region (E^3).

Political and Economic Conditions.—The various territories that until recently formed part of the Chinese dominions are now in a condition of political change due to the extension of Russian influence from the west and to the extension of Japanese conquest from the east.

China Proper occupies an area of nearly 1½ million square miles, including parts of the temperate, sub-temperate and tropical monsoon lands and, behind these, parts of the margins of the central highlands. As these regions are generally well-watered and thoroughly cultivated, the population is dense and estimated to amount to over 400 millions—the largest of any State in the world.

The great agricultural production of China Proper is due in part to the physical factors of summer heat, abundant rainfall, and the fertility of the alluvial and loess soils, and in part to human factors, such as the methods of thorough cultivation, including widespread irrigation. The people are most careful and industrious gardeners (for gardening is a better term than farming for this intensive cultivation), and the forests have long since largely given place to agriculture.

In the centre and south rice is the most important crop. It requires very intensive labour and its great yield makes possible the sustenance of that labour. Overlapping rice in the centre and extending to the north is wheat, grown on an even larger area than rice. In much the same regions as wheat, barley and maize are obtained. In northern China, two important grain crops are millet and kaoliang. Soya beans are now a widespread crop, used for several purposes.

Pigs and chickens are reared all over China, but few other animals except draught oxen. Fish, from rivers and ponds, are an important element in the diet of the Chinese.

Silk is produced almost everywhere, but it is declining both in quantity and in quality. Cotton is grown mainly in the basin of the middle and lower Yangtse, sugar-cane in the extreme south, and tea in the regions indicated on the map in Fig. 111. Opium

has been an important crop of the more mountainous regions of the west and north.

The mineral wealth is great. Coal exists in almost every province of China Proper and Manchukuo, and its amount is probably greater than in any other country excepting the United States; the greater deposits, however, lie mainly in the interior and as yet are but little worked. Iron and salt are abundant in the centre, and copper, silver and tin in the south-west of China Proper.

Metal working is on a small scale, but the making of silk and cotton goods and the milling of rice and wheat are being developed. The resources in raw materials, minerals and labour will in the future afford the basis of great manufacturing industries.

The slow development of the country was due largely to the conservatism of the people, and the extent to which the mountains and deserts of the interior isolated these productive regions from European influence. Also, there is a lack of transport, for of the great rivers only the Yangtse is navigable far into the interior. That river is navigable for steamers for more than 1,000 miles, while the city of Hankow, the great inland centre of trade, can be reached by ocean-going vessels. The river Yangtse, therefore, has a great amount of traffic, mainly concerned with domestic trade, and near its mouth is Shanghai, which is the largest city in China, with 3½ million inhabitants, and carries on more trade than any other Chinese port. The upper Yangtse and the greater part of the courses of the Hwang-ho and the Si-kiang are impeded by rapids, and the shifting channel of the Hwang-ho is a difficulty in its lower course. Near the mouth of the Si-kiang is Canton. The Imperial (or Grand) Canal connects the rivers flowing into the Gulf of Pechili with the mouth of the Yangtse, crossing the alluvial plain of the Hwang-ho from north to south.

Railways are as yet very few, being most important in the north, where they connect the old capital, Peiping (Peking) with Tientsin, the Gulf of Pechili and southern Manchuria to the east, and to the south with the basin of the Hwang-ho and with the Yangtse at Hankow and at Nanking, which followed Peking as the capital of China.

Manchukuo, or Manchuria, has been detached from China and made an independent State under the dominance of Japan. It forms a large part of the temperate monsoon region and its productions are similar to those of north China, though large areas are still forested uplands. On about half-a-million square miles lives a population of over 30 million people, nearly all Chinese, who cultivate grain and soya beans.

Mongolia and Sinkiang (including Chinese Turkestan), on the north-western margins of the central highlands, have come largely under Russian influence. Although their area is huge they have only a small population, of mixed origin, in part nomadic herdsmen and in part cultivators of irrigated river-valleys and oases. Caravan routes meet at the capital, Lhasa.

Tibet in the heart of the Asiatic Highlands, is practically independent, and its relatively few inhabitants have little communication with the outside world.

Hong Kong, a fortified British possession, is a small island off the mouth of the Canton River and a commercial gateway to China.

JAPANESE EMPIRE

Natural Regions.—*Monsoon Lands :* Portions of the Temperate Monsoon Region (E^1) ; Portions of the Subtropical Monsoon Region (E^2).

Political and Economic Conditions.—The area of Japan[1] (150,000 square miles) is only one-tenth that of China Proper, and its population (over 70,000,000) is one-fifth that of its greater neighbour. Thus Japan in regard to both area and population is decidedly larger than Britain, while in regard to density of population the two island groups are somewhat similar. In the case of Japan, however, the comparatively dense population is due largely to the agricultural resources of the country as well as to manufacturing and commerce.

The mountainous character of Japan reduces the agricultural area to a little more than one-tenth of the total surface, but, as in China, the summer heat and abundant rainfall, together with the skill and industry of the people, result in a great production.

[1] Japan Proper, excluding Korea (or Chosen), Formosa (Taiwan), and Japanese Sakhalin (Karafuto), which add over 100,000 square miles.

Both the lowlands and the terraced hills bear rice, which is the chief agricultural product ; nevertheless, rice and other foodstuffs have to be imported. Barley, rye and wheat are cultivated, but the total area given to these crops is much less than that devoted to rice. Mulberries are widely grown, except in the northern islands, and the quantity of silk from the silkworms which feed upon the leaves is great, but as in other countries the silk production has declined owing to the competition of artificial silk (rayon). Tea, cotton and tobacco are grown in the sub-tropical monsoon area.

The chief mineral is coal, but the annual yield, although increasing, is not great. Some gold and copper are also mined. The poverty in minerals is in part compensated by an abundant supply of water-power. The fisheries of Japan have considerable importance.

Manufacturing has developed remarkably, both in small domestic work and in factory organisations. Silk, rayon, cotton and other textile goods are produced, and recently metallurgy, machine-making and chemical industries have become important. The industrial development is shown in the foreign trade : the chief imports are raw cotton and wool, iron and metals, and rubber, while the exports include rayon and cotton goods, raw and manufactured silk, and various manufactured small articles such as glass-ware and toys.

The great cities of Japan are situated either on or near the coast, and the largest lie around three inlets of the southern shores of Honshiu (the "Mainland"). The capital, Tokyo, with about seven million people, is at the head of the Bay of Tokyo ; nearer the entrance of this bay is its port Yokohama, which can accommodate larger vessels. Farther to the west lies Nagoya, at the head of an inlet which also is not deep enough for large modern ships in its upper portion. Still farther west is Osaka, with three million inhabitants, on the Bay of Osaka ; this city, too, is hampered by the silting up of the inlet, and the port of this district is Kobe, on the opposite side of the bay. Behind Osaka lies Kyoto, the old capital of Japan. Nagasaki, on Kiushiu, is a port which has the advantages of a good harbour facing China, and local supplies of coal.

The island of **Formosa** was ceded in 1895 by China after its defeat by Japan. The island has a population of about six millions, and produces tea, camphor, sugar and rice.

As a result of the Russo-Japanese war, the southern part of Sakhalin was ceded to Japan in 1905. At the same time **Korea** was taken under Japanese protection, and in 1910 it was annexed. This peninsula is more than half as large as Japan Proper, but its population is only about twenty-five millions; the capital is Seoul. It is almost entirely an agricultural country, producing rice, beans, wheat, tobacco, cotton and hemp. There are coal, iron, copper, gold and other minerals, but these are little worked.

FRENCH INDO-CHINA

Natural Regions.—*Central Highlands:* Portions of the South-eastern Margins (D^3). *Monsoon Lands:* Portions of the Tropical Region (E^3).

Political and Economic Conditions.—The eastern portion of Indo-China is a French possession with 25 million inhabitants. The northern province is Tong King; the delta of the Song-ka bearing great crops of rice is at present the productive and populous part of this province, the interior being a highland continuation of China and possessing valuable deposits of coal and other minerals. South of Tong King is Laos, mainly forested highland, while the out-curving portion of the east coast is known as Annam. The upper portion of the Mekong forms the western boundary of French Indo-China, but the lower course and delta of this river comprise the fertile provinces of Cambodia and Cochin China. Rice is the chief production of the alluvial land; the mountainous regions have great resources in their timber and minerals, and the cultivation of spices, cotton, tea, coffee and other products is carried on. The chief towns are Hanoi on the Song-ka, and Saigon near the Mekong estuary.

SIAM

Natural Region.—*Monsoon Lands:* Portions of the Tropical Region (E^3).

Political and Economic Conditions.—The heart of the peninsula is the independent state of Siam, with 15 million people. (1) In

the east is the land drained by tributaries of the Mekong, but the many rapids have isolated this region and prevented its development. (2) In the centre is the basin of the Menam; the banks of this river and its tributaries, together with its delta at the head of the Gulf of Siam, are the home of the bulk of the people of Siam. Rice growing and fishing are the chief occupations of the valley folk, and the forests yield timber and rubber; consequently rice, rubber, teak, and dried or salted fish are the principal exports. (3) In the south, Siam possesses a considerable part of the isthmus connecting the wider extremity of the Malay Peninsula with the mainland; the characteristic product of this region is the tin from the granitic mountain range. Bangkok, on the Menam delta, is the capital and the only town of importance.

THE STRAITS SETTLEMENTS AND MALAY STATES

Natural Region.—*The East Indies and Philippines* (K).

Political and Economic Conditions.—The wide extremity of the Malay Peninsula comprises four "Federated Malay States," which are under British protection, together with three much smaller areas which form the British "Straits Settlements." These are Penang, at the north-west of the region, Malacca on the Strait of Malacca, and Singapore, an island at the southern end of the peninsula. As in the Siamese territory to the north, plantation rubber and tin are the chief products which are exported; there are also copra, palm-oil, fruit and timber. Singapore, the port which stands on the island of the same name, has developed rapidly in consequence of its situation at the extremity of the peninsula which separates eastern Asia from southern Asia, Africa and Europe. It is now a great centre of trade and a strongly fortified naval dockyard and air-port.

THE MALAY ARCHIPELAGO

Natural Region.—*The East Indies and Philippines* (K).

Political and Economic Conditions.—The islands between the Indian and Pacific Oceans may be divided into three groups. Bordering the Indian Ocean are the Sunda Islands, of which the largest are Sumatra and Java; these are all Dutch, with the exception of the eastern portion of Timor, which is Portuguese.

Sugar, rubber and petroleum are the chief commodities exported, followed by copra, tea, tobacco, coffee and tin. The most productive and extraordinarily densely populated island is Java, with over 40 million people; Batavia is the seat of government of all Dutch East Indies and one of the chief centres of trade.

The central group of islands consists of Borneo, Celebes and the Moluccas or Spice Islands. This group is entirely Dutch, except the north-west portion of Borneo, which is under British protection. The products are much the same as those of the Sunda Islands.

The north-eastern group comprises the Philippine Islands, now a Commonwealth under the suzerainty of the United States. The most important island is Luzon, on which stands the capital, Manila. Sugar, Manila hemp, copra, coco-nut oil and tobacco are exported.

Almost all parts of the archipelago have mineral deposits. At present there is but little mineral production, besides oil, tin and some coal and gold.

CEYLON

Natural Region.—*The East Indies and Philippines* (K).

Political and Economic Conditions.—The island of Ceylon should be grouped with the East Indies rather than with India in respect of climate, and politically it is quite separate from the Indian Empire. It is half the size of England, with about six million people, and is adminstered by a British Governor.

The heat and rainfall are considerable and well distributed through the year, the soil is fertile, and there is an abundance both of plant and animal life. European traders have established great plantations of rubber, cacao, cinnamon and tobacco. Enormous numbers of coco-nut palms supply food to the people, and copra, fibre and oil for export. Rice is an important crop, and yet has to be supplemented by importation. The mineral resources include graphite, rubies and sapphires, and there are pearl fisheries in the north. All these products (except the rice) are exported. Colombo, the capital, is the great port of Ceylon; it is also a central point in the Indian Ocean and therefore an important fueling-station.

BURMA

Natural Regions.—*Central Highlands:* Portions of the South-eastern Margins (D^3); *Monsoon Lands:* Portions of the Tropical Region (E^3).

Political and Economic Conditions.—Burma is now, like Ceylon, a Crown Colony of the British Commonwealth independent of India; on an area more than twice that of the British Isles it has a population of about 16 million people. It is very similar to other portions of Indo-China in structure and productions, and rice is the chief product of agriculture. Most of the people live along the coastal lowlands, or in the valleys and deltas of the rivers. The navigable Irawadi therefore connects the populous areas; Mandalay is the centre of the interior lowlands, and Rangoon stands on the great delta. Much petroleum is exported, though most of the other minerals except silver are little worked. A considerable export of teak and rice is carried on from Rangoon.

THE INDIAN EMPIRE

Natural Regions.—*Monsoon Lands:* The Ganges Plain (E^3); The Indus Plain (E^4); the Dekkan (E^5). *Central Highlands:* Portions of the South and South-western Margins (D^3 and D^4). *South-western Plateaus:* The South-eastern portion of the Iran Plateau (F^1).

Political and Economic Conditions.—India consists of a Federation of British Provinces and of Native States, all having a certain measure of self-government, but subject in particular respects to the Viceroy appointed by the British Government. Its total extent is 1,800,000 square miles, and it has a population of over 350,000,000 persons. This great population is very diverse in regard to race, language and religion, as was shown in Chapter XII. The Gurkhas' country of **Nepal**, in the central Himalaya region, is an independent Kingdom. The differences in regard to relief and rainfall lead to great differences in the economic activities of the various regions.

The basin of the Ganges and Bramaputra is the most productive and densely populated part of India. Here there is a great summer rainfall, but in the drier part the fields are irrigated either with water brought by rivers and canals from the mountains,

or with the water from wells sunk through the soft soil. Jute and indigo are grown on and around the delta, and rice everywhere except in the higher and drier regions, where its place is taken by millets; rice and millets form the chief food-stuffs of the people. Tea and timber are obtained from the mountain slopes, wheat is grown around the upper courses of the Jumna and Ganges, and the sugar-cane and oil-seeds are fairly widely distributed.

Calcutta, with 1½ million inhabitants, stands on the delta. Besides being a port it was the seat of government, but Delhi, on the Jumna, is now the capital and in the hot season the administration is transferred to Simla, in the Himalayas. Delhi and Agra are famous in history, with beautiful buildings. Cawnpore on the upper Ganges is becoming important as a manufacturing centre, for here, as at Calcutta, Bombay and elsewhere, the making of textiles, especially of cotton and jute, is developing. The raw materials are produced in the country, there are deposits of coal within and on the margins of the Dekkan, there is an abundance of cheap labour and a great market for such goods among the huge population. Lucknow, Allahabad and Benares are other great towns of this region.

The basin of the Indus extends far into the Himalayan highlands in the native State of Kashmir. Because the head-streams of the river have cut valleys in the north-west highlands, there are here passes through which have come past invasions, and until recently the mountain tribes descended upon and plundered the dwellers in the lowlands. Both to provide against invasion and to ensure the peace of the borders, the Empire has been extended into the highlands, and the passes have been fortified. Specially noteworthy are the Khyber Pass leading to Afghanistan, on the Indian side of which are the military stations of Peshawar and Rawalpindi, and the Bolan Pass in Baluchistan, which has been made a province of India. Owing to the scanty rainfall, the fertility of the Punjab is due largely to irrigation from its five rivers, the Indus, the Jehlum, the Chenab, the Ravi, and the Sutlej; this irrigation is the work of the British Government, and it has made possible the growth of great quantities of wheat. Cultivation extends as a narrow strip along the lower Indus, but widens again at the delta. The chief towns of the Punjab

are Lahore and Amritsar, and the port of the region is Karachi, west of the delta.

The Dekkan has three types of vegetation. (1) The mountainous western and northern borders are forested. They have sheltered some of the most backward tribes, and have little economic importance, except for timber (chiefly teak), and in the south the plantations of tea and coffee. (2) The interior has normally but little rain, and when the supply is below the normal, the drought is very serious; consequently famines are more frequent here than in other parts of India. This region is largely a grassland, the river valleys being naturally the more fertile portions. Millets are a common crop, and wheat is obtained in the northern part. Cotton is grown in the north-west upon the "black cotton-earth," a volcanic soil which retains moisture long after the rains have ceased. (3) The fertile coastal lowlands have abundant summer rains in the west, and no lack in the east; also the deltas of the rivers flowing into the Bay of Bengal are irrigated by canals. All these lowlands have a great production, especially of rice and millets; consequently they are densely populated. Coal is found near the north and north-east borders of the Dekkan; in the latter region, near the Ganges delta, iron is also found and iron-works have been established. Gold, manganese and other minerals are mined to some extent. The Western Ghats give water-power used in the cotton mills in and near Bombay. The largest cities are Bombay on an island off the west coast, Madras on the east coast and Haidarabad in the interior.

The railways of India are now very extensive. The Indus and the Ganges are useful waterways, but the rivers of the Dekkan are impeded by rapids and the fluctuations in the volume of water render navigation difficult. The chief exports are raw and manufactured jute, raw and manufactured cotton, oil seeds, tea, hides and skins, various metals and ores; the imports are chiefly cotton goods, machinery and other metal goods. Much of this commerce passes through Calcutta; Bombay, owing mainly to its sheltered harbour and comparative nearness to Europe, is also very important, while Rangoon, Madras and Karachi share most of the remaining trade. A caravan route through Srinagar, Leh, and the Karakorum Pass, leads to Central Asia.

AFGHANISTAN

Natural Regions.—*Treeless Plains:* Portions of the Caspian-Aral Region (C^2). *Central Highlands:* Portions of the South-western Margins (D^4). *South-western Plateaus:* Portions of the Iran Plateau (F^1).

Political and Economic Conditions.—Afghanistan is an arid region of mountain and plateau, its barrenness relieved only by fertile river valleys where irrigation is possible. The population is probably about twelve million, and consists of many tribes of hardy, warlike people, owning scanty allegiance to the King of Kabul. This city is therefore the capital; it stands upon the Kabul river, which flows eastward into the Indus from near the centre of the country. From the centre westward flows the Hari-Rud, and in its cultivated valley is Herat, near the Persian border. Other rivers flow to the south-west into the relatively fertile depression of Seistan; the largest of these rivers is the Helmand, on one of the head-streams of which is the city of Kandahar, whose name, like that of Kabul and Herat, is associated with the warfare which has throughout history characterized this "buffer land" between India and the lands of the north-west.

IRAN (PERSIA)

Natural Regions.—*South-western Plateaus and their Borders:* Portions of the Iran Plateau (F^1), of the Highlands (F^2), and of the Plains around Mesopotamia (F^3).

Political and Economic Conditions.—In most respects Iran resembles Afghanistan, but its southern boundary is formed by the coast of the Persian Gulf and the Gulf of Oman; in the south-west it includes part of the alluvial lowlands at the head of the Persian Gulf, and part of its northern boundary is the shore of the Caspian Sea. It is far larger than Afghanistan, and has about fifteen million people. Tehran, the capital, and Tabriz are the largest towns. As in Afghanistan, cultivation is dependent upon irrigation, and the keeping of goats and sheep is an important occupation, for the wool is used for the manufacture of carpets and shawls of great value. Oil is found in the south-western mountains, and is piped to the coast by a British Company. Trade is carried on by means of caravans, and besides the oil,

rugs and carpets, the chief exports are fruits and some opium and silk. The imports are of cotton goods, machinery, sugar and tea.

SOUTH-WESTERN ASIA

Natural Regions.—*The South-western Plateaus and Highlands* (F^2). *Mesopotamia and the neighbouring Plains* (F^3). *The Mediterranean Borders* (G). *Arabia* (H).

Political Conditions.—After the war of 1914-18, **Turkey** retained little more than Asia Minor, in which the people are practically all Turks professing the Mahometan religion, but it gained by a more efficient government which has encouraged great internal developments. The State has about 17 million people, and the new capital of Ankara is becoming a modern city.

Syria extends from the Mediterranean to northern Mesopotamia. It is an independent republic which was earlier under a French mandate from the League of Nations ; most of its 2 million inhabitants are Mahometans. South of the Syrian republic are Lebanon and other territories where there is a larger proportion of Christians, and the government is still under French control.

Further south again is **Palestine,** which has been governed under a British mandate ; a difficult situation has arisen by the immigration of many Jews into an area which had been inhabited, though sparsely, by a predominantly Mahometan Arab population.

Transjordan, though under the Palestine mandate, has been made, an independent Arab Kingdom. **Iraq** consists essentially of the greater part of Mesopotamia. It is another Mahometan country which has obtained complete independence ; its subjects number about 3 millions.

The remaining part of South-west Asia is known as **Arabia.** Apart from relatively small states such as Yemen and Oman and the British Protectorate of Aden, all by the southern coasts, it forms the Kingdom of Saudi Arabia. Arabia has an area of about a million square miles, but because of the largely desert conditions its Mahometan population numbers only about 10 million persons.

Economic Conditions.—The most populous portions are the north-western lowlands which by climate and productions belong to the Mediterranean lands. The plateau of Asia Minor is on the whole infertile, and though opium, wheat and other crops are

grown it is more suited to pastoral than to agricultural occupations. On the eastern border the highlands of Armenia and Kurdistan are largely unproductive, but oil obtained from Kirkuk in Iraq is piped across the Syrian desert to the Mediterranean. Mesopotamia is capable of much more irrigation and cultivation than at present, and dates are exported from the Euphrates-Tigris delta. These rivers are navigable; ocean steamers can ascend to Basra and river steamers to Baghdad.

In Asia Minor the chief port is Smyrna, whence raisins and figs, opium, cotton, and barley are exported. From this port, as from the coast of Asia Minor opposite Istanbul, railways ascend to the plateau, and the Baghdad railway links this region with the Euphrates and Tigris lowlands and the Persian Gulf; thus it forms an important link between India and the Far East on the one hand, and the Mediterranean and Europe on the other. A branch passes through Aleppo and Damascus, the two great centres of caravan trade between the Mediterranean Sea and Mesopotamia, and skirting the desert continues southward by the Pilgrims' Road to Medina, near Mecca.

The Syrian port of Beirut and the oasis of Damascus are separated by the Lebanon and Anti-Lebanon ranges, but are joined by a railway. From Damascus another line passes through Samaria and the fertile plain of Philistia, and skirting the Mediterranean coast links this region with Egypt. Jerusalem is on the rather bare highland of Judea, but is connected by rail with this line and also with the port of Jaffa. Adjoining Jaffa is the large Jewish settlement of Tel Aviv, and the neighbouring coastal plain has been developed, especially for fruit.

Yemen is the most fertile part of Arabia, and is famous for its excellent coffee. Near the entrance to the Red Sea is Aden, a small British possession and an important coaling-station.

Cyprus, in the Eastern Mediterranean, forms part of the British Empire. Its products, wheat, wine, olives and silk, are typical of the regions of summer drought.

AUTHORITIES AND BOOKS FOR FURTHER READING.

Géographie Universelle, Tomes 5, 8, 9 (Paris: Colin).

L. Dudley Stamp: *Asia* (Methuen).

CHAPTER XXVI

NORTH AMERICA—PHYSICAL CONDITIONS

Position and Extent.—North America is a triangular-shaped land-mass, broad in the north, where it is broken up into numerous islands, and narrow towards the south, where the Isthmus of Tehuantepec may be taken as its limit. It thus extends from within 20° of the north pole to within 20° of the equator, the greater part lying within the temperate zone. The narrow and shallow Bering Strait, often ice-blocked, alone separates it from Asia to the west, while towards the east it is linked up with Europe through Greenland, Iceland and the Faroe-Icelandic submarine ridge. To the south, Central America and the narrow Isthmus of Panama form a land bridge to South America.

RELIEF, STRUCTURE AND DRAINAGE

Main Divisions.—According to relief the continent falls into four divisions, the eastern highlands, the western highlands, and the interior plains which are sub-divided into northern and central regions, for the badly drained northern area, with its numerous lakes and irregular, complicated river systems contrasts strongly with the central area which forms the basin of a single vast river system, that of the Mississippi. These four divisions correspond to four structural divisions (see Fig. 55); the eastern highlands have been carved out by erosion from an old uplifted crustal block; the western highlands are of more recent date, and are due to folding, fracturing, and uplift on a very large scale; the northern plain is the oldest part of the continent, consisting of very ancient rocks worn smooth by age-long erosion;

the central plain is built up of sedimentary rocks, many of them very old, which have been undisturbed by any folding.

The Eastern Highlands.—These highlands stretch from Newfoundland in a south-westerly direction almost to the Gulf of Mexico, and form the Appalachian System. Two facts in their past history have an important bearing on the present relief; in the first place the northern part has been depressed and the southern part uplifted, and in the second place the northern part was covered by the ice-sheet during the Ice Age (see Fig. 33). Owing to the movement of depression, the highlands in the north are close to the sea, and the lower parts of the valleys are drowned, forming a very irregular coast-line; moreover, these valleys have been deepened by glaciers, and so take the form of fiords. The land is continued under the sea by a wide continental shelf, of which the Great Banks of Newfoundland form the most important part. Owing to the movement of uplift, the highlands in the south are on the whole higher than those in the north and are separated from the sea by a coastal plain of soft sedimentary rocks which has a relatively unbroken shore-line. The general trend of the feature lines is from north-east to south-west, but the Appalachian System is cut across from east to west in two places. The first is the Mohawk-Hudson valley, which formed the channel through which the water from the Great Lakes escaped when the ice-sheet still covered the land to the north. The second is the St. Lawrence estuary, the present outlet of the Great Lakes; this river has worn a deep channel, Cabot Strait, which separates Newfoundland from the mainland, and is now submerged beneath the sea owing to the sinking of the land.

The block from which the Appalachians are carved was an old peneplain, itself the result of the prolonged erosion of an older mountain system. In the area to the south of the Hudson River this peneplain consisted of narrow bands of alternately hard and soft rocks which have given rise to a series of parallel ridges separated by valleys and notched by narrow water-gaps. The most easterly of these ridges is known as the Blue Ridge, and on the western margin is the Allegheny escarpment which presents a steep face eastwards and dips gently westward to

the central plains. To the north-east of the Hudson River many of the surface features are the result of glaciation ; deep, irregular deposits of boulder clay have interrupted the drainage, so that small lakes are numerous, while the rivers cutting down through these soft deposits have in many places reached hard, buried ridges which formed part of the original surface, and at these points their courses are broken by rapids and waterfalls.

Rocks bearing coal and iron ore are an important feature in the Appalachian System.

The Western Highlands.—This great highland system stretches from the Isthmus of Tehuantepec to the Bering Sea, where the volcanic Aleutian Islands link it up with the mountainous island loops which border Asia. The name Rocky Mountains is now usually confined to the bordering ridges which overlook the central plains. As in the case of the eastern highlands, the northern area, once heavily glaciated, contrasts with the southern area ; the northern part of the western coast has been drowned and the inlets take the form of fiords, while a series of islands, of which Vancouver is the largest, corresponds to the Coast Range, which forms the almost unbroken shore-line south of Puget Sound, and to the highland peninsula of Lower California. Parallel to this westernmost line of heights are the Cascade Mountains, which extend behind the coast of British Columbia, and the Sierra Nevada which are continued southward along the coast of Mexico by the Sierra Madre. Between the parallel ranges lies the flat-floored Californian valley, filled with fertile alluvium brought from the neighbouring mountains, and drained by the Sacramento and San Joaquin rivers ; corresponding to this valley but farther south is the Gulf of California.

The northern part of the highland system consists mainly of well-marked lofty ridges, such as the Gold and Selkirk Ranges, while the rivers, of which the Fraser and Upper Columbia are typical, flow in deep zig-zag valleys ; but farther south the ridges separate to embrace wide plateaus and basins. Across a great plateau built of horizontal layers of basalt the Snake and Lower Columbia rivers flow in cañons sometimes 3,000 feet deep ; farther south the Colorado River has cut its still deeper and more famous cañons into a plateau consisting of vast horizontal

layers of sedimentary rocks. Between the Wahsatch Mountains and the Sierra Nevada lies the Great Basin, which has no outlet to the sea, with the result that the ridges which cross it are half buried under accumulations of rock-waste; this basin is dotted with salt lakes, of which Great Salt Lake is the largest. Farther to the south the western and eastern Sierra Madre enclose the plateau of Mexico, which is partly drained by the Rio Grande del Norte, but of which a considerable area has no outlet, so that here too there are saline depressions and great accumulations of rock-waste.

Throughout the western highlands are scattered both active and extinct volcanoes, such as Popocatepetl (18,000 ft.), and many localities are subject to earthquakes (see Fig. 56); in the Yellowstone National Park, which is a lava plateau crossed by the deep Yellowstone cañon, there are numerous geysers and hot springs. No such evidences of crustal instability are found in the older parts of the continent. In the extreme north, the interior of the Alaskan area drained by the Yukon River is little known, but like the rest of the mountain system it is rich in valuable minerals. Mount Mackinley is the highest peak.

The Northern Plain.—The ancient peneplain of granites and crystalline schists, known as the Laurentian Shield, slopes towards a depression filled by the waters of Hudson Bay. Its boundary is roughly defined by a series of great lakes, of which the Great Bear and Great Slave Lakes form part of the Mackenzie system draining to the Arctic Ocean; Lake Winnipeg, which receives the waters of the Saskatchewan, has an outlet, the Nelson River, to Hudson Bay, while Lakes Superior, Michigan, Huron, Erie and Ontario are drained by the St. Lawrence River to the Atlantic Ocean. Between Lakes Erie and Ontario are the famous Niagara Falls and Gorge; at the close of the Ice Age, when owing to the melting of the ice from the St. Lawrence valley the waters from the lakes again flowed north-eastwards, the stream from Lake Erie fell over the edge of a steep limestone escarpment, and since then, owing to erosion, the waterfall has worked its way farther and farther up-stream, thus gradually carving out the narrow gorge. The drainage of the Great Lake region underwent several changes at the close of the Ice Age,

and at one time the three upper lakes were drained through Georgian Bay, Lake Nipissing and the River Ottawa, a route along which the construction of a canal has often been suggested.

The ice-sheet has left numerous traces upon the surface of the peneplain ; in many places the rocks are scratched, polished, and scraped bare of soil, while glacial waste fills the valleys and hollows. Numerous lakes occupy waste-blocked valleys and ice-scooped rock basins, and owing to the gentle slopes and the impermeable nature of the rocks much of the land is badly drained and swampy. The larger lakes which outline the border of the peneplain were once even more extensive, and large deposits of fertile alluvium mark the sites from which they have retreated. The greatest of these older lakes occupied the area in which now lie Lakes Winnipeg, Winnipegosis and Manitoba, and the Red and Saskatchewan Rivers ; its sediments form the level and exceptionally fertile wheat fields of this region. The ancient rocks of which the peneplain is composed are rich in valuable minerals, including copper, gold, nickel and iron.

The Central Plains.—Great plains of undisturbed sedimentary rocks form the basin of the Mississippi, whose waters are separated by almost imperceptible divides from those flowing to Hudson Bay and the St. Lawrence. The plains rise gradually westwards to a height of over 3,000 feet before the foot of the Rocky Mountains is reached, and their surface is undulating rather than level. Two important tributaries of the Mississippi, the Missouri and the Ohio, approximately indicate the southern boundary of the area once covered by the ice-sheet. The rivers of the plain have encroached upon the neighbouring regions on either hand, for the headwaters of the Missouri, Platte, Arkansas, and many others are behind the bordering Rocky Mountain ridge, in which they make important gaps, while the Upper Tennessee forms one of the longitudinal valleys of the Appalachian System. The rivers from the west bring down enormous loads of silt, and below the Ohio confluence the Mississippi meanders over a wide alluvium-floored flood-plain, bordered by low bluffs, finally entering the Gulf of Mexico, where it is constantly extending its large delta. On the portion of the plains once covered by the ice-sheet there are extensive glacial deposits, including

moraines, boulder-clay, and loess, the latter being also found over a considerable area far to the south of the once glaciated region. Among the sedimentary rocks which underlie the plain are some that are rich in coal-measures.

CLIMATE

Pressure, Winds and Rainfall.—*January*. In this month, which is typical of the winter conditions, the average pressure over the interior of the continent is relatively high, and the precipitation therefore low. The stormy westerlies sweep the west coast as far south as 35° S., causing a rainfall which is made heavier by the relief. Cyclones passing north-eastwards from the Gulf of Mexico, and eastwards from the Great Lakes, are the cause of the winter rains in the eastern regions; but the frequent formation of anticyclones with outblowing winds over the cold interior makes strong north-westerly and westerly winds prevail as a rule, except in the southernmost regions.

July. In this month, although there is no well-marked low pressure area over the continent which could be compared to that over Asia, yet the pressure is slightly lower than over the neighbouring oceans. The stormy westerlies have shifted northwards, and bring rain only as far south as Vancouver; but the rainy belt stretches right across the continent from west to east. The trade winds are drawn in over the southern plains and Mexico, which have their chief rainfall at this season.

Annual and Seasonal Rainfall.—The seasonal rainfall map (Fig. 82) shows that north of about 45° N. the west coast has rain at all seasons, while the interior in the same latitudes has summer rains; south of this latitude the west coast has a summer drought with rain at the other three seasons, and still farther south rain in winter only; the mountain-girt basins and plateaus, and the western plains have no rainy season, or at most summer rains, while the eastern area has rain at all seasons. The meridian 100° W. corresponds approximately to the isohyet of 20″, and the plains to the west of this are only scantily watered, but whereas south of about 50° N. this rainfall is so distributed that no season has as much as 6″, to the north of this parallel the precipitation is chiefly in the summer months which have over

6″; this fact, combined with the decreased evaporation in the north, makes the rainfall which is available for plant life in the growing season more abundant, so that the vegetation becomes richer towards the north, although the mean annual rainfall does not increase.

Snowfall.—In the regions lying to the north of the January isotherm of 0° C. (see Fig. 61) which have cold winters, much of the precipitation at this season takes the form of snow; thus in eastern Canada where the winter precipitation is considerable, there may be a snowfall of from 6 to 10 feet, but over the drier plains to the west there is less than 2 feet.[1] Immediately under the lee of the Rocky Mountains the warm dry chinook wind frequently blows (see p. 131), and rapidly clears the ground of snow. On the Western mountains north of about 45° N. the snowfall is again abundant except in the coast ranges, where the temperatures are milder. The limit of perpetual snow is 8,000 feet at lat. 50° N., while even in the extreme south such lofty peaks as Popocatepetl are snow-capped.

Temperature.—There is a great contrast between the west coast, which has warm on-shore winds, and the east coast, which has cold off-shore winds in winter; the former is mild in winter, warm in summer, while the latter shows a wide temperature range similar to that of the interior of the continent The western basins and plateaus are very hot in summer in spite of their altitude, partly because the air is so dry and there is little cloud to check insolation; the coasts of Mexico which lie within the tropics are hot all the year round, while even the northern shores of the Gulf of Mexico have a mean annual temperature of 20° C. The cold Labrador current intensifies the inclemency of the climate of Labrador, which lies in the same latitudes as the British Isles, and yet is a barren tundra region.

VEGETATION AND ANIMALS

Vegetation.—(See Fig. 95.) Greenland and some of the islands of the far north, being covered with perpetual snow, have no vegetation; they are true deserts. The northern borders of

[1] It must be remembered that a foot of snow is roughly equivalent to an inch of rain.

the continent with the adjacent islands form the Barren Lands, with a vegetation of the tundra type; farther south there is a gradual change to coniferous forest, spruce, fir, larch and pine, with the broad-leaved birch, the formation stretching right across the continent in the belt with summer rains; the wet, mild west coast is also clothed with coniferous forest, but the species of trees are different, many of them, such as the Douglas firs, being of enormous dimensions, and the growth is more luxuriant than in the interior. In the mountains many of the higher ridges are above the tree line, and Alpine pastures gay with flowers are followed by bare rocks and snow-fields. On the well-watered east coast the coniferous forest is mixed with broad-leaved deciduous trees such as oak, maple and hickory and in the eastern United States the natural formation is broad-leaved forest, although much of the land has been cleared for agriculture. In the interior of the continent beyond the inner border of the forests is a belt of rich grasslands or prairies, in which there is some admixture of woodland, while still farther inland, on the dry western plains, the grass becomes coarser and scantier, and trees almost entirely disappear. The arid plateaus and basins of the western mountains have a semi-desert vegetation of scrub, the characteristic plant being the sage-brush, while towards the south thorny cactuses and yuccas are common. The hot coasts of Mexico have a tropical vegetation, chiefly forest on the wetter east coast, and savannah on the rather drier west; the land rises rapidly towards the plateau, and the tropical palms and hardwood trees are succeeded by forests of oak, and these in turn by conifers.

Animals.—Seals and whales are found in the cold waters of the north, and on the shores of the cold deserts and the Barren Lands the polar bear obtains food from the sea. In the summer the musk ox, the caribou and countless birds move northwards to the moss-covered tundra, but in the winter they retire southwards to the forests, in which there are many valuable fur-bearing animals, such as the mink, sable, ermine, fox and beaver. The great grassy plains beyond the forests were once the grazing grounds of vast herds of bison, but these were nearly all destroyed during the latter half of the nineteenth century. Both the plains

and the scrub regions support numerous burrowing rodents such as the prairie dog and jack-rabbit, small flesh-eating animals such as the coyote or prairie-wolf, and grazing animals such as the prong-horned antelope. On the western mountains the Rocky Mountain sheep, the Rocky Mountain goat and the grizzly bear are characteristic animals, while on the tropical margins of Mexico many of the animals of South America, such as monkeys, armadilloes and humming-birds, are found. The Labrador current brings an unfailing supply of plankton to the Newfoundland Banks, which therefore form a feeding and breeding ground for innumerable fish, among which the cod and herring are the most important. The fiords and sounds of British Columbia are also rich in fish, and in the rivers salmon are abundant.

NATURAL REGIONS

A. Greenland.—This lofty plateau is buried under an ice-sheet such as once spread down to the banks of the Missouri and Ohio ; the ice creeps slowly towards the coast, and great masses are broken off and float as icebergs southwards on the Labrador Current. Deep fiords fringe the coast, and the sea is the only source of food, but it is rich in fish, seals and whales.

B. The Appalachian System.—B^1. *The Northern Region.* The uplands are still heavily timbered, chiefly with conifers, the valleys are filled with fertile glacial soils, and glacial action is indirectly the cause of the abundance of water power. The climate is extreme, and the precipitation, including snow, is abundant ; over the neighbouring shallow seas, which teem with fish, fogs are frequent owing to the chilling of the air by the cold Labrador current. Deep natural harbours occur all along the coast.

B^2. *The Southern Region.* The long, narrow, parallel ridges are well wooded, and are separated by fertile cultivated valleys which form easy routes from north-east to south-west behind the outermost or Blue Ridge. The rivers Susquehanna and Potomac cross the whole width of the upland, but they follow zig-zag courses, and have merely cut notches (water-gaps) through successive ridges. The wide, level-floored Hudson-Mohawk valley makes an easy route-way from the coast to the

Great Lakes, and is connected too with the Lake Champlain and Richelieu valley leading down to the St. Lawrence. The southern valleys, including the upper Tennessee, enjoy the mild winters of the neighbouring plains.

C. The Western Highlands.—C^1. *The Alaskan Highlands.* The best-known part of this region is the wooded valley of the Yukon river, which includes the Klondike goldfields; it is surprisingly warm in summer, and vegetables can be grown, but the whole region is snow-bound in winter.

C^2. *The Northern Ridges and Valleys.* This is a mountain region of the Alpine type, with bare, jagged peaks rising above snowfields and glaciers, and with many lakes in the deep steep-sided valleys. The Fraser River valley, reached by passes across the Rocky Mts., is the chief route-way of the region. The snowfields of Mount St. Elias feed a great glacier which reaches the sea. The vegetation includes mountain forest and natural pasture, and mixed farming is possible in the valleys.

C^3 and C^{3a}. *The Southern Basins and Plateaus.* These are essentially semi-desert regions, and where the rainfall falls below 10 inches a year actual desert tracts occur such as the Mohave and Gila Deserts. The accumulated rock-waste forms a fertile soil, and in many districts the streams and rivers fed by the bordering mountains yield water for irrigation; elsewhere the vegetation of scrub and scanty tufts of grass affords pasture for stock. C^3 includes the Great Basin in which lies Great Salt Lake, together with the Columbia River Basin to the north, and the Colorado River Basin to the south. C^{3a} is the high plateau of Mexico, which increases in altitude southwards, and so has a uniform temperature from north to south: very hot in summer, but cool in winter. The rainfall also increases slightly towards the south. Minerals are abundant, as they are throughout the Western Highlands.

D. The Western Margins.—D^1. *The Temperate Region.* This is an abundantly watered belt with a mild climate, and the lofty mountains which rise abruptly from the fiord coast are clothed with dense coniferous forest. It includes Vancouver Island.

D^2. *The Transition Region.* In this region also the rainfall is abundant, the climate mild, and the mountains heavily

timbered; here, however, the summers are dry and cereals and fruit ripen well, especially in the fertile Sacramento valley.

D^3. *The "Mediterranean" Region.* In this region rain falls in winter alone, and agriculture is only possible with irrigation; the luscious fruits, including grapes and oranges, which are characteristic of this type of region grow to perfection in the fertile San Joaquin valley. On the border of this region and the last, the combined waters of the Sacramento and San Joaquin cut through the coast ranges; a slight depression has caused the sea to drown this transverse valley, and thus a splendid natural harbour has been formed opening westwards through the Golden Gate.

E. The Northern Plains.—E^1. *The Barren Lands.* This tundra region borders the cold seas which are rich in seals and whales; inland the country consists largely of desolate lakes and swamps, the breeding-ground in summer of myriads of insects.

E^2. *The Northern Forests.* This great forest region has a climate characterized by summer rains, and intense winter cold, so that the Lake ports and those of the St. Lawrence and Hudson Bay are closed for four months or more. Many of the trees yield valuable timber, and on the southern margins large areas have been cleared for agriculture, especially where old lake-alluvium or glacial-waste affords a fertile soil. Gold and other minerals are abundant between Lake Huron and James Bay.

F. The Central Plains.—F^{1a}, F^{1b}. *The Prairies.* In this region the loose, rich soils, which include loess, alluvium and boulder-clay, together with the light summer rains and high summer temperatures, favour a rich growth of natural grasses with some admixture of woodland, and the same conditions are admirably suited to the growth of cereals. Although the summer climate is fairly uniform throughout the region a further sub-division is necessary, for in the district marked F^{1b} (which includes most of the peninsula between Lake Huron, Ontario and Erie), the winters though cold are shorter and less severe than in the district marked F^{1a}; moreover, the mean

annual precipitation is heavier, spring and autumn being rainy seasons as well as summer. Here maize becomes important.

F². *The High Plains.* These high treeless plains are characterized by their low rainfall and high summer temperature; the vegetation of coarse grass with occasional scrub is suitable for pasture for stock, and from the lofty Rocky Mountain ridge come streams which can be employed for irrigation, for in many parts the soil is good. In the south of this belt the summer heat is excessive.

F³. *The Lower Mississippi Basin.* This is a region once forested, but now largely cleared for agriculture, although still an important source of timber. Owing to its fertile soils and its favourable climate, characterized by mild winters, hot summers, and a plentiful rainful well distributed through the year, it produces valuable crops of cotton, maize and tobacco.

F⁴. *The Mississippi Flood-Plain and the Coastal Plains.* This region is built of soft sedimentary rocks and recent alluvium; much of it is badly drained and swampy, as for example part of the flood-plain, the Great Dismal Swamp in N. Carolina, and the Everglades of Florida; the coast is bordered by lagoons and fringing sand-bars. The Mississippi is confined by artificial banks or levées, but in spring it still causes widespread floods, which are sometimes disastrous. The drowning of the northern part of the Atlantic Coastal Plain has brought tidewater to the edge of the Appalachian Region by Delaware River and Chesapeake Bay. The climate is similar to that of the region F³, but the summers are still hotter, so that even tropical crops can be grown, though these are imperilled by the occasional occurrence of severe frosts, due to the winds which in winter may sweep unhindered from the cold northern plains. The low-lying peninsula of Florida which projects southwards from the plain is built of limestone, and in the south is little more than a swampy wilderness. Its Atlantic coast is a famed winter resort.

G. The Tropical Margins of Mexico.—G¹. *The Eastern Margins.* G². *The Western Margins.* The coastal lowlands of these regions are tropical in their vegetation, animals, climate and products; they form the tierra caliente or hot belt. In the

ascent from the coast to the plateau of Mexico, the tierra caliente gives place in succession to a sub-tropical belt, the tierra templada, and to a cool belt, the tierra fria. From lat. 20° the Western Margin suffers from insufficient rainfall.

For Authorities and Books for further reading, see end of Chapter XXVII.

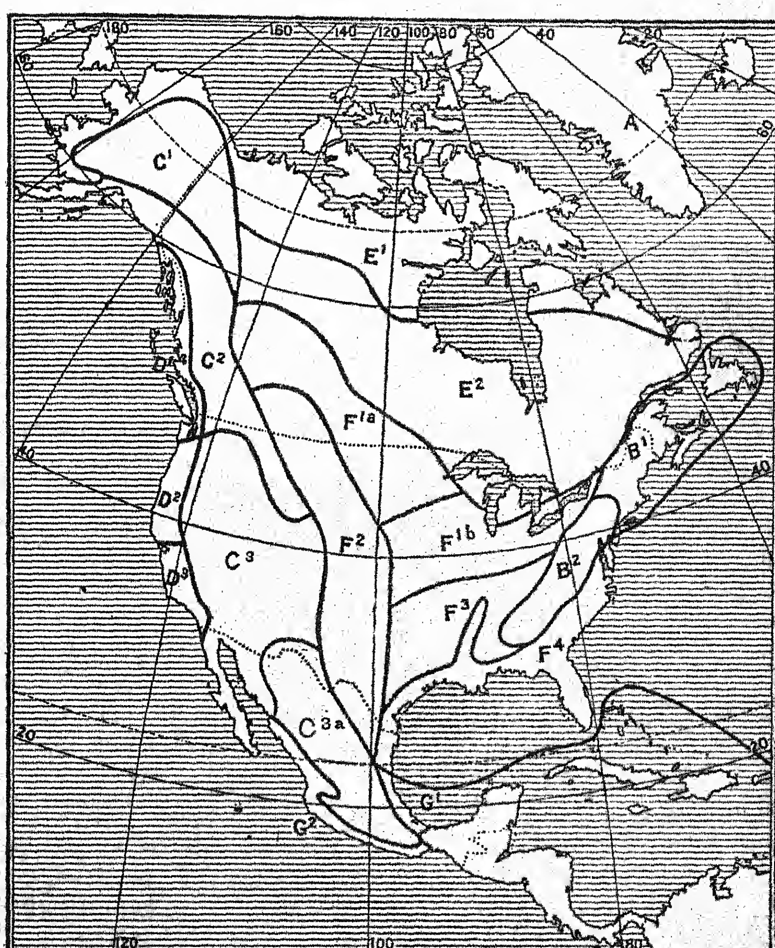


FIG. 129.—North America. Natural Regions.

CHAPTER XXVII

NORTH AMERICA—POLITICAL AND ECONOMIC CONDITIONS

THE DISCOVERY AND SETTLEMENT OF THE NEW WORLD

The taking of Constantinople by the Turks in 1453, and their subsequent conquest of Egypt, made trade with the East almost impossible by the old Mediterranean route. The value of that trade, which consisted mainly of such products as spices, precious stones, gold, silver, and ivory, was so great that it led to a search for other routes to the Indies; hence the voyage of Vasco da Gama in 1497, when he sailed round the Cape of Good Hope and so reached India. But even before this Columbus hoped to gain the same end by sailing westwards across the Atlantic Ocean, for a map of the time showed him Japan lying in the same latitude as the Canary Islands at a distance which he estimated at about 2,500 miles. So in 1492 he set out from Spain, and sailing into the trade wind belt, was carried by winds and currents to the West Indies, whose name perpetuates his mistake in at first thinking he had reached his goal. From that time many expeditions sailed, both to share in the wealth of this New World, as it was soon realized to be, and to attempt to find a sea-passage to the old Indies by avoiding these new land-barriers. Thus in 1519 Magellan crossed the Atlantic, bearing to the south, passed through the Strait that bears his name, and crossed the Pacific to the Indies, whence his ship returned by the Cape of Good Hope. Similarly a "North-west Passage" was attempted, first by Cabot who sailed from Bristol in 1497 and discovered Newfoundland, and later by others, including Hudson who went out in the interests of the Dutch and sailed up the broad Hudson River, at

first thinking it to be a strait leading to an ocean beyond. In 1613 Hudson perished in another attempt in Hudson Bay.

South America was explored and annexed largely by the Spaniards and Portuguese, and Central America by the Spaniards, while north of the Tropic of Cancer, the British, Dutch and French were rivals. The St. Lawrence River was the entry which the French explored, and they occupied the region around its estuary. Quebec, on the St. Lawrence, was founded by Champlain in 1608, and his countrymen made their way up the river to the Great Lakes, across to the Mississippi and down that river till their explorations linked up with those of the Spaniards, who had penetrated by way of the Gulf of Mexico. The Dutch had settlements near the Hudson River, but these passed into the hands of the British, who from 1587 onward had made colonies at many points along the coast between Florida and the St. Lawrence region, and occupied the lowlands between the sea on the one hand and the Appalachian and New England mountains on the other. Conflicts between the British and French resulted at length in the decisive capture of Quebec in 1759, and in 1763 all Canada was ceded to Great Britain.

DOMINION OF CANADA AND NEWFOUNDLAND

Natural Regions.—*Appalachian System:* The northern extremity of the region (B^1). *Northern Plains:* The Barren Lands (E^1); the Northern Forests (E^2). *Central Plains:* The northern portion of the Prairies (F^{1a} and F^{1b}); the northern portion of the High Plains (F^2). *Western Highlands:* The eastern part of the Alaskan Highlands (C^1); the greater part of the Northern Ridges and Valleys (C^2). *Western Margins:* The Temperate Region (D^1).

Historical and Political Survey.—Newfoundland very early attracted fishermen from Europe, and claims to be the first colony of England. It was finally acknowledged as British at the beginning of the eighteenth century, but the French fishermen retained rights over the western portions of the shore. This was felt by the British inhabitants to be a grievance, and partly for that reason Newfoundland refused to join with the other portions of British North America when they united to form the Dominion

of Canada; in 1904 the French relinquished their rights over the shores, though they may still fish in the neighbouring waters. Newfoundland has its own government, its capital being St. John's.

The present provinces of Nova Scotia and New Brunswick, at that time united under the name Acadia, were finally ceded by the French in 1713. Cape Breton Island, now a part of the province of Nova Scotia of which it is naturally a continuation, and Prince Edward Island, still a separate province although so small in extent, became British in 1763 together with the great region comprising the St. Lawrence valley and the northern shores of the Great Lakes. This region was divided later into Lower Canada (now Quebec) and Upper Canada (now Ontario). Quebec, was settled by the French and in consequence the inhabitants are still mainly French in descent and speech, and Roman Catholicism is the predominant form of religion. The more distant Ontario was not actually colonized by the French, though it was under their influence, and now the English speech and the Protestant religion are predominant there, as in the greater part of British North America.

The central part of Canada early passed into British hands, for in the latter part of the seventeenth century the Hudson Bay Company was formed to trade in the furs from the great forests; this company retained the lands for 200 years, until they surrendered them to the Dominion. Manitoba was created a province in 1870, but it was not until 1905 that the "North-west" was divided into regions to which the rights of provinces were assigned.

British Columbia was settled much later than most of the other provinces; the British did not take possession even of the coastal portions until 1790, and there was little immigration until gold was discovered about 1855.

Self-government was granted to the older and better settled provinces long before they united in 1867 to form the Dominion. The central government has its seat at Ottawa, on the banks of the river Ottawa, which separates the two most important provinces. This central government deals with all affairs common to the Dominion, while the governments of the Provinces are restricted to certain matters of local importance.

The population of the Dominion is about eleven millions, and of this number over three and a half millions are in Ontario and over three millions in Quebec. In comparison with the size of the Dominion, which almost exactly equals that of Europe, the population is extremely scanty. In Ontario nearly all the people live in the " Lake Peninsula " between Lakes Huron, Erie and Ontario, in the region immediately north of Lake Ontario, and in that between the rivers Ottawa and St. Lawrence. In Quebec the population is practically confined to the banks of the St. Lawrence and that part of the province lying south of the river between the cities of Quebec and Montreal. Indeed, most of the Dominion, with the exception of the maritime regions and a narrow strip along the southern boundary, may be said to be still largely uninhabited.

Agriculture, Forestry and Fishing.—Although agriculture is the chief occupation of the people of Canada, only a very small percentage of the land is under cultivation. In the north and north-east the temperatures are insufficient for crops ; around Hudson Bay the hard glacier-polished rock is extremely unfavourable for agriculture ; in the west the mountains largely prohibit cultivation ; in the high plains region (F^2) the rainfall is in some years deficient, with the result that crops fail and the dry soil may be blown from the farmed land.

On the other hand, the prairie region (F^{1A}) is exceptionally favoured both by its climatic conditions and by the soil derived from fine glacial deposit, while the "Lake Peninsula" and the neighbouring valley of the St. Lawrence have abundant warmth and rain for the products of temperate latitudes. (Compare the summer isotherms and rainfall with those of Europe in similar latitudes.)

As cheap transport is a necessity for marketing the products, a railway map gives a good idea of the most important agricultural regions, which coincide largely with the populated areas referred to in the preceding section. Alberta and Saskatchewan still have prospects of considerable developments.

The most important crop is wheat, and the amount produced is so large in comparison with the requirements of the relatively small population, that Canada is one of the chief sources of wheat for Britain and other densely populated countries of

Europe. The chief wheat-producing area is in the prairie region, stretching diagonally from south-western Manitoba west of Winnipeg and Lake Manitoba, across Saskatchewan south of the north branch of the Saskatchewan River, and into eastern Alberta between the North and South Saskatchewan rivers.

Wheat-raising is no longer " one-crop " farming to which bad weather may be disastrous ; oats, barley, clover and other products are obtained from the wheat areas. Oats are largely grown also in the St. Lawrence lowlands of Ontario and Quebec. Potatoes and other vegetables have a wide range, especially towards the north.

Fruit of many kinds is grown in the coastal regions both east and west, but most notable in this respect is the " Lake Peninsula " which penetrates so far southward. Here, in addition to the products mentioned, tobacco and the vine are cultivated.

Almost everywhere dairy farming is carried on, cheese being an important product in the St. Lawrence lowlands, where also large numbers of pigs and poultry are kept ; on the high plains of Alberta the rearing of cattle, horses and sheep is important.

The forested portions amount to nearly one-third of the total area, and in all these, except in the north where transport is difficult, lumbering is an industry of considerable importance.

The shallow waters of the Atlantic Coast yield great quantities of fish, cod being specially valuable ; the lakes of the central part of the Dominion are well stocked in fish, and there are large establishments in British Columbia, particularly by the Fraser River, where salmon are canned.

Mining and Manufacture.—The mineral resources are great. Coal (See Fig. 130) is obtained in New Brunswick, Nova Scotia and Cape Breton Island in the Northern Appalachian regions (B^1), by the Crow's Nest Pass over the Rocky Mountains, and in Vancouver Island in the west. Moreover, extensive deposits exist in the Prairie Provinces, especially in Alberta, but as most of this supply consists of lignite, its utilization has been slow. Natural gas and oil also are obtained, the latter especially in Alberta and in the Mackenzie valley.

Iron ore is mined near the coal in Nova Scotia and in Newfoundland, an iron industry being consequently established at Sydney in Cape Breton Island. Iron is found at many other

places, including Michipicoten, on the shore of Lake Superior. The Appalachian region has important supplies of asbestos.

Gold is also widely distributed, the greatest amount coming from the "Laurentian Shield." The most productive area is south-west of Lake Abitibi in Ontario, while less amounts are obtained in Quebec and in Northern Manitoba. Gold is also mined in the Western Cordillera, and small quantities in Nova Scotia. Besides gold, the Laurentian Shield affords most of the world's supply of nickel, near Sudbury, and also silver, cobalt, and copper. Near Great Bear Lake is a very important source of radium. British Columbia yields silver, lead, copper and zinc.

The manufactures are steadily developing. The sawing and pulping of timber; the making of wooden articles; the manufacture of leather, cotton and woollen goods; the construction of agricultural and other machinery and motor cars; the preparation of food-stuffs—these are all of importance. The stores of coal, gas and oil will aid very great developments, and also important will be the water power obtained both from the streams of the western highlands and from the rapids of the once glaciated regions, where the numerous lakes form natural reservoirs to ensure a steady flow of water and a constant supply of power.

Communications and Commerce.—The drowned coasts afford many excellent harbours, but these are only utilized in the south-east and south-west, owing to the lack of trade and the severity of the climate in the north. The western shores are indeed always ice-free, but the only ports which have as yet developed are Victoria on Vancouver Island, the capital of British Columbia, Vancouver by the Fraser River, the terminus of the trans-continental Canadian Pacific Railway, and Prince Rupert further north. On the east, the mouth of the St. Lawrence is blocked by ice in winter, and in that season Halifax, the capital of Nova Scotia with a fine harbour ice-free throughout the year, becomes the chief eastern port of the Dominion. St. John in New Brunswick is similarly ice-free, this being due largely to the action of the strong tides of the Bay of Fundy. During most of the year the great entry is the St. Lawrence; on its north bank is Quebec, the capital of the province, although in size far surpassed by Montreal, with about a million inhabitants, which has the

advantage of being at the head of navigation on the river. Montreal stands upon an island which has facilitated the bridging of the river, and south of the city opens the valley of the Richelieu and Hudson Rivers, leading to New York. Montreal is the chief eastern terminus of the Canadian Pacific Railway and the commencement of the great system of inland navigation. Above Montreal are the Lachine Rapids, but these are avoided either by the Lachine Canal or by the route up the Ottawa River which here joins the St. Lawrence. This route leads to Ottawa, above which are the Chaudière Falls giving power to large saw-mills. These falls have been avoided by the cutting of the Rideau Canal between the Ottawa river and Lake Ontario. On the shores of this lake are Toronto, the capital of the province of Ontario and an important railway centre, and Hamilton, where the extremity of the lake extends far into the fertile peninsula. To proceed up the lakes, vessels go through the Welland Canal leading into Lake Erie by a course parallel to the Niagara River, from Lake Erie into Lake Huron, and thence by the "Soo" Canals at Sault Ste. Marie into Lake Superior, where the terminal points on the Canadian shore are Fort William and Port Arthur. The lakes provide magnificent waterways for both Canada and the United States, and far more traffic passes through the "Soo" Canals than the Suez Canal.

A shorter route for the central and northern prairies is by railway from Fort Churchill on Hudson Bay to the Saskatchewan River; its disadvantage is that Hudson Strait is ice-free only between July and November.

West of Lake Superior, transport is largely by railway. Winnipeg, the rapidly growing capital of Manitoba, is like a port for the prairie regions, for from this city westward the lines radiate out fan-like, and are being gradually extended farther to the north. Another important railway centre is Regina, the capital of Saskatchewan.

The Rocky Mountains are crossed west of Fort McLeod by the Crow's Nest Pass leading to the Kootenay mineral region, and west of Calgary by the Kicking Horse Pass by which the main line proceeds to the Pacific coast. From Calgary a line runs northward to Edmonton, the capital of Alberta, and from

this point the Grand Trunk Pacific Railway has constructed a new line across the mountains by the Yellowhead Pass, having a terminus at Prince Rupert behind Queen Charlotte Islands.

The greatest exports of Canada are wheat; wood, wooden goods and paper; dairy produce; ores and metals of gold, nickel, copper, etc.; meat and fish. The imports are chiefly iron and steel goods and machinery; coal and oil; cotton and woollen goods; sugar.

THE UNITED STATES

Natural Regions.—*Appalachian System:* Southern portion of the Northern Region (B^1); the Southern region (B^2). *Northern Plains:* Portions of the Northern Forests (E^2). *Central Plains:* Southern portions of the Prairies (F^{1a} and F^{1b}); Southern portions of the High Plains (F^2); the Lower Mississippi Basin (F^3); the Mississippi Flood-Plain and the Coastal Plains (F^4). *Western Highlands:* The Alaskan Highlands (C^1); Northern and Southern extremities of the Northern Ridges and Valleys (C^2); Northern portions of the Basins and Plateaus (C^3). *Western Margins;* Southern extremity of the Temperate Region (D^1); the Transition Region (D^2); the "Mediterranean" Region (D^3).

Historical and Political Survey.—During the seventeenth century British, Dutch, German and Swedish settlements were made in the coastal regions between the present Canadian territory and Florida; the region east of the Hudson valley is still known as New England. By the eighteenth century these had all become British, and in 1776 thirteen states declared their independence and formed the "United States of America." Although some of these states claimed territory extending behind the Appalachians, only the coastal region and the larger river valleys were effectively occupied. As the interior was settled other states were formed and admitted into the Union. At the beginning of the nineteenth century the plains west of the Mississippi, then known as Louisiana, were purchased from France; shortly afterwards the north-western region from the Rockies to the Pacific was occupied; later, Florida was ceded by Spain; about the middle of the century the south-western

region, including Texas and California, was obtained by conquest and purchase from Mexico and Spain; still later the detached area of Alaska was purchased from Russia. At the end of the century the United States assumed responsibilities beyond the seas by the annexation of Hawaii, the Philippines and Porto Rico.

Now the States number 48, and in addition there are some Territories with less independence. Each state has its own government, dealing with all matters not specially reserved for the Federal Government. This has its seat at Washington, a city situated on the River Potomac in a piece of territory belonging to no one state and named the District of Columbia. At the head of the Republic is the President, who is elected for a period of four years.

With the inclusion of Alaska, the area of the United States is a little more than 3,500,000 square miles, and the population is about 140,000,000 persons. Of this population about 12,000,000 are Negroes, living chiefly in and around the Mississippi flood-plain and the southern coastal plains (F^3 and F^4). Immigration is now strictly limited, few settlers being admitted from central and eastern Europe, and from China and Japan.

Forests and Agriculture.—As in Canada, so in the United States about one-quarter of the land is still forested, and of this forest-land one-third is in the western marginal and highland regions, and the remaining two-thirds are in the east.

The great highland and arid or semi-arid regions still further reduce the cultivated area, and at present only about one-sixth of the land is under cultivation. This proportion will increase by the gradual extension of farming into the semi-arid lands beyond the 100th meridian and by the adoption of irrigation still farther west where streams bring water from the mountains. Moreover, the prairie region was at first but poorly cultivated, but it is now being farmed much more intensively.

Wheat and oats, maize, tobacco, cotton, rice and sugar are typical products; the regions in which they are grown indicate the relative requirements of the crops when it is remembered that both heat and moisture increase from north to south in the central plains. Also hay and alfalfa fodder for animals, and fruit and vegetables for man, are widely produced.

In the far north of the prairie region (F^1) spring-sown wheat is the main crop, autumn-sown (winter) wheat being grown further south. Oats, with some barley and flax, are other products of the northern prairie region. The same crops are widely grown in the eastern portion of the country in the same latitudes, for the Appalachian region, although less suited to the growth of cereals than the prairies, was earlier settled and cultivated. Large quantities of wheat are raised in the fertile valley of California, and the valleys of Oregon and Washington yield the same crop. The greatest production is around the Red and Minnesota Rivers, in the states of North and South Dakota and Minnesota.

In the southern portion of the prairie region (F^{1b}) maize is by far the most important crop. The area of greatest production is that between latitudes 37° and 43° bounded on the west by the high plains and on the east by the Ohio river, but only in the extreme north and south of the whole country east of 100° W. is this crop unimportant. The eastern parts of Nebraska and Kansas, Iowa, Missouri, Illinois, Indiana and Ohio together produce about one-half of the world's crop of maize.

Tobacco is grown in the Ohio valley, Kentucky producing the greatest quantity, and also in the corresponding latitudes east of the Appalachians where North Carolina and Virginia yield the largest amounts, though the cultivation extends as far north as the Connecticut valley in New England.

South of latitude 37° (in regions F^3 and F^4) cotton is the most valuable agricultural product; eastern Texas, Mississippi, Alabama, Arkansas, Georgia, Louisiana and South Carolina rank first in yield, and indicate the area of greatest production.

In the coastal regions of the south and extending northward up the Mississippi valley (F^4) the sugar-cane and rice are cultivated, but the value of these products is not as great as those mentioned above. The sugar-beet is grown in higher latitudes, mostly in the prairie region and in California.

In many parts the cultivation of fruit for export is developing. Specially important are the apples from the north-east, the oranges and grape-fruit of the extreme south, and the grapes (from which wine is made), pears, pineapples, oranges, and

lemons, apricots and olives of the "Mediterranean" region of California.

Pastoral Work and Fishing.—The pastoral industries of the United States are extremely valuable. Far greater numbers of cattle and pigs are reared than in any other country, mainly because of the quantities of maize on which they are largely fed; for this reason, also, the southern part of the prairies (F^{1b}) is the area where most of the cattle and pigs are kept. Cattle are reared also in the north-eastern states and in California; in all these regions dairy farming and the making of butter and cheese are occupations of some importance. On the open grazing lands of the high plains cattle are reared chiefly for their flesh and hides, and sent eastward for slaughter and export.

Sheep are kept more for the sake of their wool than for meat, and are widely distributed over the States. In the high plains and the western highlands they are far more numerous than cattle, though less important if the United States are considered as a whole. Horses and mules are bred in vast numbers, not only for home use but for export to Europe.

The fishermen of the United States engage in whale fishing in Arctic waters, and there are three important fishing grounds farther south. (i) The continental shelf from Chesapeake Bay northwards to Newfoundland yields much fish, especially cod, herring, mackerel and halibut; the headquarters of this industry is Gloucester, in Massachusetts. (ii) The north-western coast, including the Columbia River and the Alaskan shores, has great salmon fisheries; the cooking and canning of the salmon have become an important industry in the states of Washington and Oregon, and particularly on the banks of the Columbia River. (iii) The Great Lakes, with the exception of Lake Ontario, yield whitefish, trout and sturgeon.

Mining.—Coal and petroleum are the most important minerals. The output of each is greater in the United States than in any other country; together with the great amount of water-power, they afford the mechanical basis of the enormous industrial development. A quarter of the coal produced is anthracite, obtained mainly from the Appalachian region in the eastern part of Pennsylvania; the rest is of poorer quality, and the districts from which it is

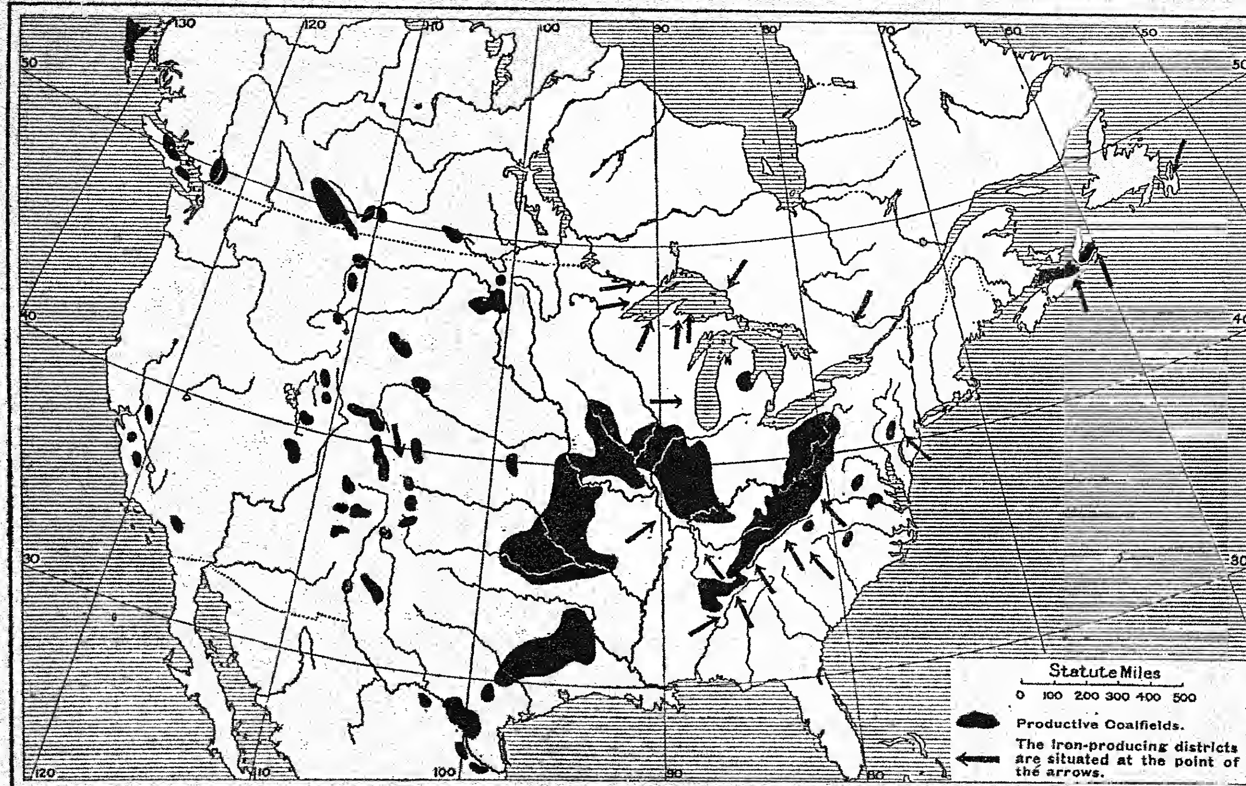


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FIG. 130.—Sources of Coal and Iron Ore.

mined may be grouped into four regions (see Fig. 130), in order of importance: (i) The Appalachian field, on the west side of the Appalachian system, where the layers dip below the central plains from western Pennsylvania and West Virginia to Alabama, smaller areas lying on the eastern edge of the Appalachian system; (ii) the central field, where the greatest quantity comes from the state of Illinois; (iii) many small scattered fields in the western highlands and their margins; (iv) a relatively unproductive though large area in Texas.

The production of petroleum is enormous; it is obtained in great quantities from the Mississippi Basin in Texas, Oklahoma and Kansas, and from California. Much is sent from the "Gulf ports" to Europe. Natural gas is in many cases associated with the oil, but the supply is comparatively soon exhausted; it is used for manufacturing purposes in the northern part of the country.

The predominance of the United States is as marked in the production of iron ore as in that of coal. Great deposits of very rich ore exist in the Laurentian Shield west and south of Lake Superior, so that north-eastern Minnesota and north-western Michigan supply most of the output of the whole country. Next in importance is the southern Appalachian region, where Alabama holds the first place; iron is, however, widely distributed and Pennsylvania and several other states produce considerable amounts (see Fig. 130).

Copper is also mined on the southern shores of Lake Superior but greater quantities are obtained from the western highlands, especially from Montana and Arizona.

Gold and silver are found in most of the states of the western highlands, and gold is mined in Alaska. California, Alaska, Colorado and South Dakota produce most gold; Utah, Montana, Arizona and Idaho produce most silver; Denver, at the eastern edge of the highlands, is an important distributing centre. Lead is found chiefly in association with the silver; zinc is another mineral of importance, and quicksilver is obtained from New Almaden in California.

Manufactures.—The abundant supply of raw materials and power, and the great population, have enabled the United States to become the greatest manufacturing nation. The chief indus-

tries may be grouped as follows: the making of iron, steel and other metal goods, including machinery, electric apparatus and motor-cars; the preparation and packing of food materials, especially meat, cereals, fruit and vegetables; the manufacture of cotton, rayon and woollen goods; the working of wood and its products, including cellulose and paper; the preparation of rubber and tobacco.

Some of these industries are located close to the sources of the primary products. At convenient centres in the maize belt great numbers of cattle and pigs are slaughtered, the meat being sent away either frozen, or cooked and canned. Great packing establishments prepare these and other animal products at Chicago on the south-western shore of Lake Michigan, Cincinnati on the Ohio river, Kansas City at the junction of the Kansas and Missouri rivers, and Omaha above the junction of the Platte and Missouri rivers. Cereal-preparation is carried on in or near the same centres. Fruit is, of course, canned in the respective producing districts. The manufacture of timber products is widely distributed, but furniture-making is largely carried on in Chicago, at Grand Rapids and New York.

The localization of the iron and steel industries depends mainly upon facilities for bringing together the ore and fuel. The greatest production is in western Pennsylvania, in and around Pittsburg-Allegheny, which is situated where the Monongahela and Allegheny rivers unite to form the Ohio. Here fuel (coal, oil and gas) is obtained from the northern part of the Appalachian coalfield, and the ore comes from the Lake Superior region by way of Lakes Huron and Erie, and thence by rail. Another region utilizing the same sources of iron and fuel is by Lake Erie, where Buffalo, Cleveland and Erie are the chief manufacturing cities; the materials are brought from west and east to this district as a convenient centre. At Detroit there is a great industry connected with motor-car construction. A third district is at the southern extremity of Lake Michigan; Chicago has great steel works, utilizing the ore from the region north of the lake and fuel from the central coalfield to the south-west, and having facilities for distribution. Of more recent development is the iron and steel industry in the southern part of the

Appalachian system. Here fuel and ore are obtained together, and of a number of centres Birmingham, in northern Alabama, is the most important.

Although so much of the world's cotton is grown in the southern states, a large part is manufactured elsewhere. About one-half is exported, and part of the remainder goes to New England, where the water-power enables it to be manufactured cheaply. The state of Massachusetts is specially important; it has many cities engaged in the cotton industry, among which are Fall River and Lowell. The utilization of the mineral resources of the southern Appalachians has greatly aided in the rise of cotton manufacturing in that region, and with the local supply of all the necessary materials, together with a suitably damp climate, this industry promises to become very great. Atlanta, at the southern end of the highlands, is the chief centre.

New England and the northern part of the Appalachian coal-field engage largely in the manufacture of woollen and leather goods. The ease in obtaining the necessary materials, and the existence of a local market among the great population of this part of the country, have led to the industries being carried on in such cities as Philadelphia, New York and Newark, and Boston.

Communications and Commerce.—With such production there is necessarily great trade and transport. One of the earliest ports was Boston, but although possessing an excellent harbour, ice-free throughout the year, this city is prevented from having easy communication inland by the mountains of New England. The trade of Boston, although very considerable, has therefore been far exceeded by that of New York, which has behind it the Hudson-Mohawk valley, affording the only easy route from the Atlantic coast to the Great Lakes and the interior of the continent. Since the lake navigation was connected with that of the Atlantic by the opening of the Erie Canal, New York has developed into the largest city of North America, now having a population of about 7,500,000 people. Situated in the centre of the most densely populated part of the coastal region, having water-fronts on either side of the Hudson River and on Long Island, with access by railway and canal to the north-west, and with other railway lines leading westward and southward across

the Appalachians, New York has become the commercial capital of the United States.

In consequence of the enormous amount of traffic on the Great Lakes, there have grown up a number of lake ports such as Rochester on Lake Ontario, Buffalo where the Erie Canal leaves the lake, Cleveland on the southern shore of Lake Erie, Detroit on the river between Lakes Huron and Erie, Milwaukee on the western shore of Lake Michigan, and, greater than all, Chicago. This city, with about 3,000,000 inhabitants, is second only to New York. Its position at the end of Lake Michigan has not only made it an important port, but also a great railway centre, where lines converge from east, south, west and north-west. Another important lake port is Duluth, which is largely concerned with the shipment of grain from the north-western prairies.

The Atlantic ports south of New York have somewhat difficult railway communication across the Appalachians. Philadelphia, on the Delaware River, ranks next to New York in the amount of trade and has a population of about 2,000,000 persons. Still farther south is Baltimore, on Chesapeake Bay, the most northerly of the ports which export the produce of the south; Charleston and Savannah also export cotton.

The Mississippi system has not only afforded water communication between the central plains and the Gulf of Mexico, but it has been connected with the Great Lakes by several canals. River traffic, however, is much less important than railway traffic, and centres which first arose because of their position on a waterway have been developed mainly in consequence of the railways which were built to converge upon them. Thus St. Louis, just below the junction of the Missouri and Mississippi, is now important as a railway centre. Other large centres of railway traffic are Minneapolis on the upper Mississippi, Cincinnati, Columbus and Indianapolis.

The great port at the mouth of the Mississippi is New Orleans, by which much of the produce of the central and southern states is exported. Its trade in cotton is shared by the other Gulf ports, Galveston and Mobile.

Although there are several trans-continental railway lines, the arid and highland areas interpose a great barrier between the

eastern and western parts of the country and there is relatively little trans-continental trade. The productive regions of the west are not comparable in extent with those of the east, and the western coast has few good harbours. In the north-west Seattle and Tacoma are developing on Puget Sound, and Portland (Oregon) can be reached by sea-going ships, but the only great port is San Francisco. It is the gateway of the fertile valley of California, and the terminus of trans-continental routes through Chicago and St. Louis. The southernmost route, from New Orleans, passes through Los Angeles, the greatest settlement in the western half of the States, and the centre of a fruit-growing, oil-mining, film-producing and pleasure-seeking population.

The chief exports of the United States are iron and steel goods, machinery, and motor-cars ; cotton and cotton goods ; petroleum and other oils ; meat and grain products ; tobacco. Among the chief imports are rubber ; silk and silk goods ; coffee ; sugar ; paper and paper goods ; wool and woollen goods ; furs.

MEXICO

Natural Regions.—*Western Highlands :* The southern portion of the Basins and Plateaus (C^{3a}). *Central Plains :* Southern extremities of the High Plains (F^2) and of the Coastal Plains (F^4). *Tropical Margins of Mexico :* The Eastern Margins (G^1) ; The Western Margins (G^2). *Central America :* The Yucatan Peninsula and the Isthmus of Tehuantepec.

Political and Economic Conditions.—The wealth of Mexico in gold and silver led to its conquest by Spanish adventurers, and the country remained a Spanish possession till the early part of the nineteenth century. It then revolted, and is now a republic with the seat of government at the city of Mexico, near the southern extremity of the plateau. Mexico resembles the States of Central and South America in deriving its Spanish language and Roman Catholic religion from the Spanish conquest. The area of the country is about three-quarters of a million square miles ; the population numbers about 20 million people, about one-sixth being of European ancestry, one-quarter of Indian descent, and the remainder of mixed descent.

The sugar-cane, rice, cotton, cacao and tropical fruits are grown on the marginal lowlands, tobacco and coffee at a greater altitude, and wheat, maize and temperate fruits where irrigation makes their cultivation possible on the semi-arid plateau. In the extreme south the forests yield mahogany, logwood and rubber; and sisal-hemp is grown in Yucatan.

The mineral wealth is great. Much of the world's silver is from Mexico; gold, lead and zinc are also mined. Petroleum is obtained in large amounts, especially near Tampico. Only a little coal is mined, but the great resources of water-power are increasingly utilized. There are but small manufactures, mainly of cotton and tobacco.

Minerals, including oil, are the commodities mostly sent abroad, and manufactured goods are brought in. The chief ports are Vera Cruz and Tampico, both connected with the plateau by railway. A line connects the Gulf of Mexico with the Pacific Ocean across the Isthmus of Tehuantepec.

THE BAHAMAS AND BURMUDAS

These island groups are similar in several respects: they are of coral formation, they export fruit and early vegetables to the United States, and they are British possessions. Both are favourite tourist resorts for Americans. From the seas around the Bahamas sponges are gathered. The capital of this group is Nassau. Bermuda is a fortified naval station.

Authorities and Books for Further Reading.

Russell Smith: *North America* (Bell).
Rodwell Jones and Bryan: *North America* (Methuen).
Géographie Universelle (Tome XIII) (Colin: Paris).
Miller and Parkins: *Geography of North America* (Chapman and Hall).
Lucas and Egerton: *Historical Geography of Canada* (Oxford Press).
A. P. Brigham: *Geographic Influences in American History* (Ginn).
E. C. Semple: *American History and its Geographic Conditions* (Boston: Houghton Mifflin Co.).
M. I. Newbigin: *Canada, the Great River, the Land and the Men* (Christophers)

CHAPTER XXVIII

CENTRAL AND SOUTH AMERICA

CENTRAL AMERICA AND THE WEST INDIES

Physical Conditions.—*Central America.*—This is on the whole a mountainous region, the greatest altitudes being reached near the Pacific coast, where there are many active and extinct volcanoes. The chief lowlands are the Yucatan peninsula, which like Florida is a recent limestone formation, and the alluvial plains bordering the Atlantic coast. The largest lake is Lake Nicaragua, from the floor of which rises an active volcano; it is drained by the San Juan to the Atlantic, and a canal was at one time projected which should connect it also with the Pacific Ocean.

The rainfall is everywhere abundant except on the flat Yucatan peninsula; it falls chiefly in late summer when the belt of convectional rains has swung northward, but on the windward slopes of the highlands moisture is condensed from the north-east trades in winter also. The temperature varies with the altitude, the same division into tierra caliente, tierra templada, and terra fria being made as in Mexico (see p. 429) and in the Andes of South America.

The vegetation consists of forests of the equatorial type in the hot and wet regions, rich savannahs on the uplands, and temperate forests on the higher mountain ridges. The numerous small, swift rivers bring down great quantities of alluvium from the mountains, and this, together with the abundant volcanic soils, makes the valleys, basins and plains very fertile.

The West Indies.—The Greater Antilles (Cuba, Jamaica, Haiti and Puerto Rico) are the remains of a folded mountain system in which the parallel chains run from west to east, a direction which is followed by some of the chains in Central America, and by those

along the north coast of South America. The Lesser Antilles, a chain of volcanic islands, make a loop between Puerto Rico and Trinidad. There are also numerous groups of coral islands, such as the Bahamas. Many of the volcanoes, such as Mont Pelée and Souffrière, are active, and earthquakes are frequent.

The islands are well watered, and the uniformly high temperature is tempered towards the interior by the altitude and near the coast by the sea-breezes. The natural vegetation is a luxuriant evergreen forest, and tropical fruits and plantation products can be cultivated in abundance.

Political and Economic Conditions.—*Central America.*—South of Mexico, this region is divided into a number of small independent republics, namely, Guatemala, Salvador, Honduras, Nicaragua, Costa Rica and Panama, together with the Crown Colony of British Honduras. The total population numbers about 3,000,000 people; of these about one-quarter are Indians, and most of the remainder are of mixed origin. The chief product which is exported is coffee; bananas, coco-nuts and hides are also sent abroad. Through the State of Panama a canal has been cut connecting the Atlantic Ocean at Colon with the Pacific at Panama. "A canal zone," a strip of land ten miles wide, has been leased to the government of the United States, which undertook the work of construction. The canal was completed in 1915, and facilitates commerce particularly between the Atlantic coasts of North America and the Pacific coasts of both the Americas, besides allowing the navy of the United States to pass quickly into either ocean.

West Indies.—On the islands the natives have long disappeared, their place being taken by Negroes and Europeans. Cuba, the most important of these islands, is a republic of about 4,000,000 people. The most important product is sugar, and next comes tobacco, here classed as "Havana" tobacco, from the name of the capital whence most of it is exported; at the other extremity of the island is the port of Santiago. Coffee and bananas are also exported. Jamaica is much smaller, but has a population of over 1,000,000. It is a British possession; Kingston is the capital and chief port, and the more important exports are bananas, sugar and rum, oranges and other fruits, and coffee.

Puerto Rico, which in size, population and products resembles Jamaica, belongs to the United States. The island of Hispaniola, where the people are nearly all negroes, is divided into two republics: Haiti which produces much coffee, and Santo Domingo where sugar cultivation is the chief industry.

The Lesser Antilles belong mainly to Britain or France. Trinidad, whence oil, asphalt, cacao and sugar are obtained, is also British. Bridgetown, Barbados, is a shipping port for the whole group.

SOUTH AMERICA
PHYSICAL CONDITIONS

Position and Extent.—South America lies to the south-east of North America, with which it is linked up through Central America and the West Indies; it is also linked up with the Antarctic continent by a series of islands including the Falkland Islands, the South Orkneys and South Shetlands which are connected by a submarine ridge. With regard to latitude it stretches from 12° N. to 54° S., thus lying for the most part within the tropics, but extending farther south than either Africa or Australia. Although in its roughly triangular outline it resembles North America, it differs from the latter continent in an important respect, for whereas the northern continent is broadest in temperate latitudes and tapers towards the tropics, the southern continent has its greatest width in equatorial regions and narrows towards the pole.

RELIEF, STRUCTURE AND DRAINAGE

Main Divisions.—South America, like North America, falls into three main divisions as regards relief, the eastern highlands, the western mountains, and the central plains, which correspond to well-marked differences in structure. The eastern highlands of South America are the remains of a tableland of old crystalline and sedimentary rocks which have long remained undisturbed by any violent crustal movement; they are divided into two blocks, the Guiana and the Brazil highlands. The western mountains,

the Cordillera of the Andes, are younger than these highlands, and have been formed by folding, fracture, and uplift all on a gigantic scale. Between the mountains and the highlands until a comparatively recent geological period there were great inland seas, which have gradually become filled with silt, and now form the level plains drained by the Orinoco, Amazon and Paraguay-Parana rivers. The borders of the long mountain chains to the west and the edges of the old tablelands to the east give rise to straight, unindented coasts, and the only considerable inlet is the Plate Estuary, or Rio de la Plata.

The Guiana and Brazilian Highlands.—These highlands are the remains of a much more extensive tableland of which part has disappeared beneath the Atlantic waters. Long-continued erosion has dissected this tableland into flat-topped hills and great mesas (see p. 69) of which the steep cliff-like faces are known as serras. In Guiana the north-eastern border of the tableland has been worn down to a peneplain, which forms a broad coastal lowland, while in Brazil the tableland is tilted gently inland but descends somewhat sharply towards the sea, especially in south-eastern Brazil, where the steep escarpment receives the name of Serra do Mar. As a result of this tilt, the drainage is mainly away from the coast, either northwards to the Amazon or westwards to the Paraguay-Parana, only the São Francisco breaking through to the east, with a descent from the tableland by a magnificent waterfall.

The Cordillera of the Andes.—This mountain belt falls into three divisions, the Equatorial Andes, between 10° N. and 15° S., where there is a well-marked series of parallel ridges and valleys, the Central Andes, where the chains diverge and enclose the Bolivian plateau, and the Southern Andes, where the chains again unite. The Cordillera form a crustal belt which is still in an unstable condition, as is shown by the frequent earthquakes in certain localities, and by the numerous volcanic cones which are built up on the tops of the ridges and form some of the loftiest peaks.

The Equatorial Andes.—The series of ridges and valleys is due mainly to river erosion, but the general direction of the rivers corresponds to the direction of the folds and fracture-lines, as in the case of the rivers of the Alps and Himalayas.

Among the larger rivers are the Magdalena, which flows northward to the Caribbean Sea, and the head-streams of the Amazon, such as the Marañon, which after flowing northward turn abruptly eastwards, and cutting deep gorges through the eastern ridge, descend by rapids and waterfalls to the plain. Of the numerous volcanoes in this section of the Andes the most famous are Cotopaxi (19,600 feet) which is still active, and Chimborazo (20,500 feet) which is extinct, and now has glaciers round its crater.

The Bolivian Plateau.—This lofty plateau is about 12,000 feet above sea-level and forms an area of inland drainage. In the north is Lake Titicaca, a deep freshwater lake from which a stream flows southward to evaporate in a series of saline lagoons.

The Southern Andes.—In this section are found the lofty peak of Aconcagua (23,000 feet), an extinct volcano, and the important Cumbre or Uspallata Pass (over 12,000 feet). Towards the south the Andes more and more resemble the Alps, for snow-fields, glaciers and valley lakes become more numerous. Along the coast, parallel to the main chain and separated from it by a longitudinal valley, is a low coast range which may be compared to that in western North America ; to the south of latitude 40° S. the land has been depressed, so that the longitudinal valley is drowned and the coast range becomes a series of islands. Many inlets in this part of the coast are valleys deepened during the Ice Age by the glaciers which then came down to the sea (see Fig. 33), and they therefore take the form of fiords. In Tierra del Fuego, separated from the mainland by the Magellan Strait, the Cordillera bend eastward and are linked through South Georgia with Graham's Land.

The Central Plains.—These plains are divided into three river basins, the Orinoco, Amazon, and Paraguay-Parana, but these are separated only by low, ill-defined, swampy divides, and between the Orinoco and the Rio Negro (a northern tributary of the Amazon), there is actually a connecting river, the Cassiquiare. All the rivers of the plains carry great quantities of silt ; the Orinoco has already built up a large delta, the estuary of the Amazon is obstructed by islands and shifting mud-banks, while the Plate estuary is rapidly becoming shallower. The main stream of the Amazon is navigable to the foot of the Andes, but

its tributaries, among them the important Madeira and Tocantins, are broken by rapids where they cross outcrops of hard rock before entering the areas covered by the soft sediments of the old inland seas.

CLIMATE

Temperature.—The plains of the Orinoco, Amazon and upper Paraguay are hot in the sense that the mean annual temperature is above 20° C. (68° F.) and that the temperature is never low; but in the western mountains and the greater part of the eastern highlands the altitude brings the temperature below this average. The range of temperature is very small throughout the equatorial regions, and owing to the narrowing of the continent in the temperate region there is no area sufficiently far from the sea to have the great extremes which are typical of continental interiors in high latitudes. The temperatures of the east coast of Brazil, both in July and January, contrast with those of the west coast of the continent in the same latitudes, for a warm current flows past the east coast, and a cool current past the west coast. Cf. Figs. 61 and 62 with 78 and 79.

Winds and Rainfall.—The greater part of the continent lies in the region of abundant convectional rains, there being a considerable area near the equator with rain at all seasons, while to the north and south of it are regions which have a season of drought at their winter solstice owing to the swing of the rainy belt (see Figs. 78, 79 and 82). The north-east trades blowing towards the Guiana highlands, and the south-east trades blowing towards the Brazil highlands give relief rains to the coastal districts of these regions, while on the eastern slopes of the Andes also the relief rains are heavy. On the west coast a dry region lies about the Tropic of Capricorn, for here the winds are generally off-shore or parallel to the shore (see Figs. 71 and 72). To the south of this dry coastal strip lies the region under the influence of the stormy westerly winds; in the belt swept by these winds in winter (June, July, August) when they have their most northerly extension, there are winter rains and summer drought, while further south comes a belt which lies at all seasons in the track of the westerlies and so has rain at all seasons. The

fact that the Andes lie parallel to the coast makes the rains on their western slopes very heavy, while on the eastern or lee side of the chain there is a dry region, swept by warm dry winds. A third dry region is the plateau of Bolivia which is shut in on all sides by mountains. Cyclonic storms, passing down the Paraguay-Parana plains account for the moderate rainfall at all seasons found in the eastern regions south of the Tropic of Capricorn.

Régime of the Rivers.—The great rivers of the plains, owing to the slight slope of their beds, are very liable to overflow their banks, so that in many places they are bordered by large areas of swampy land, especially the Amazon and Paraguay. The Amazon is never low, for its northern tributaries have a maximum flow in the northern summer when the rain-belt swings northward, and its southern tributaries have a maximum flow in the southern summer when the rain-belt swings southward. The São Francisco is a river lying almost wholly in a region with a marked season of drought, so that its volume varies considerably through the year; the lower Paraguay-Parana and the Uruguay have a more uniform flow, being fed from the eastern region with rain at all seasons.

The excessive rainfall on the western slopes of the southern Andes has enabled the rivers flowing to the Pacific to work back the heads of their valleys by erosion, and so to capture many of the head-streams of the rivers flowing to the Atlantic; as a consequence the river divide here lies to the east of the main chain of the mountains.

VEGETATION AND ANIMALS

Vegetation.—The dense equatorial forest with its wealth of palms and climbing plants stretches over much of the Amazon basin where it is known as the Selvas, and is found also on the hot, well-watered Atlantic margins of Guiana and Brazil, and along the eastern base of the Andes (the Montaña). (See Fig. 95.)

To the north and south of the forest lie great stretches of tropical grassland or savannah; these include the Llanos of the Orinoco, the Campos of Brazil, and the Gran Chaco of the upper Paraguay. The savannah regions have many aspects; along the banks of rivers or on the slopes of the serras the grassland may be replaced by forest; elsewhere the typical scattered trees

(see p. 155) may be more or less numerous, so that it may be either well timbered or almost treeless; again, the grasses and herbs may be replaced by a dense scrub, such as is found in many parts of Brazil, where owing to the abundance of granite and sandstone the soils are often poor and dry. On the temperate plains the grasslands are practically treeless, possibly owing partly to the strength of the winds and the looseness of the soil, which is in some parts loess; these grasslands are known as the pampas. To the south and west of the pampas the rainfall diminishes and the vegetation takes a semi-desert character, consisting of thorny shrubs, scattered herbs and bunches of coarse grass.

Along the west coast the well-watered country north of the equator is well forested, but the dry strip farther south (which includes the Atacama desert) has a desert vegetation, consisting of a few scattered plants, with oases along the streams which come down from the Andes. The region with winter rains has evergreen shrubs and trees of the Mediterranean type, while the wet region farther south has broad-leaved forests in which the typical tree is an evergreen beech.

The succession of vegetations in the Andes is very well marked: at the base is the equatorial forest with palms and bamboos, this is followed by a sub-tropical forest with tree-ferns, this again by temperate forest in which the cinchona trees (yielding quinine) are characteristic, while at still higher altitudes the forest is replaced by shrubs and natural meadows, and finally by a bleak and often snow-covered desert bare of vegetation. The names tierra caliente, tierra templada, tierra fria, and paramos are applied respectively to the hot, warm, cool and cold belts. The high plateaus, owing to their low rainfall, are covered with a semi-desert vegetation, and form the Puna region.

Animals.—The abundance of vegetable life in the dense equatorial forests gives rise to an abundance of insects, and also of animals such as armadilloes and ant-eaters which feed upon insects. Birds and monkeys in great numbers live among the trees, while a large proportion of the animals, as for example the sloth and porcupine, have climbing habits. Many burrowing rodents living on herbs and roots, and grazing animals such as deer, are found on the grasslands, where there are also beasts of

prey such as the puma and jaguar. The rhea or American ostrich roams over the pampas and the southern scrublands. On the high pastures of the Andes live the llama, alpaca and vicuna, whose thick coats yield wool for commerce; here, too, is found the chinchilla, a burrowing rodent with a thick, valuable fur.

NATURAL REGIONS

The greater divisions are the Eastern Highlands, Western Cordillera, Central Plains and Western Margins. The Highlands of Guiana and Brazil are separated by the Amazon, and the margins of Brazil form a distinct region; the divisions of the Cordillera have been already described. The Central Plains are divided according to river basins, and of these the Paraguay-Parana basin is sub-divided by a line following roughly the isohyet of 50 inches and also dividing the tropical from the temperate regions; the southern division of the plains is made according to the vegetation. All the divisions of the western margin are based upon the distribution of rainfall.

The Eastern Highlands.

A^1. *The Guiana Highlands.*—This inaccessible region consists of tablelands, largely of sandstone, which are covered with a savannah vegetation, and are separated by deep well-wooded valleys; the courses of the numerous rivers are frequently broken by rapids and waterfalls. Gold, diamonds and mineral ores occur.

A^2. *The Brazil Highlands.*—In relief and vegetation this region is similar to the last, and like it is subject to drought, but the campos or grasslands are more extensive and are suitable for cattle ranching. Towards the south the rainfall is more uniformly distributed and agriculture is possible.

A^3. *The Eastern Tropical Margins.*—This hot and well-watered coastal strip, together with the lower slopes of the edge of the tableland, is well-forested, but has been partly cleared for tropical plantations. It faces the trade winds.

The Western Cordillera.

B^1. *The Equatorial Andes.* In this section the vertical series of climates, vegetations and agricultural products, ranging from those of the equatorial to those of the cool temperate types is the

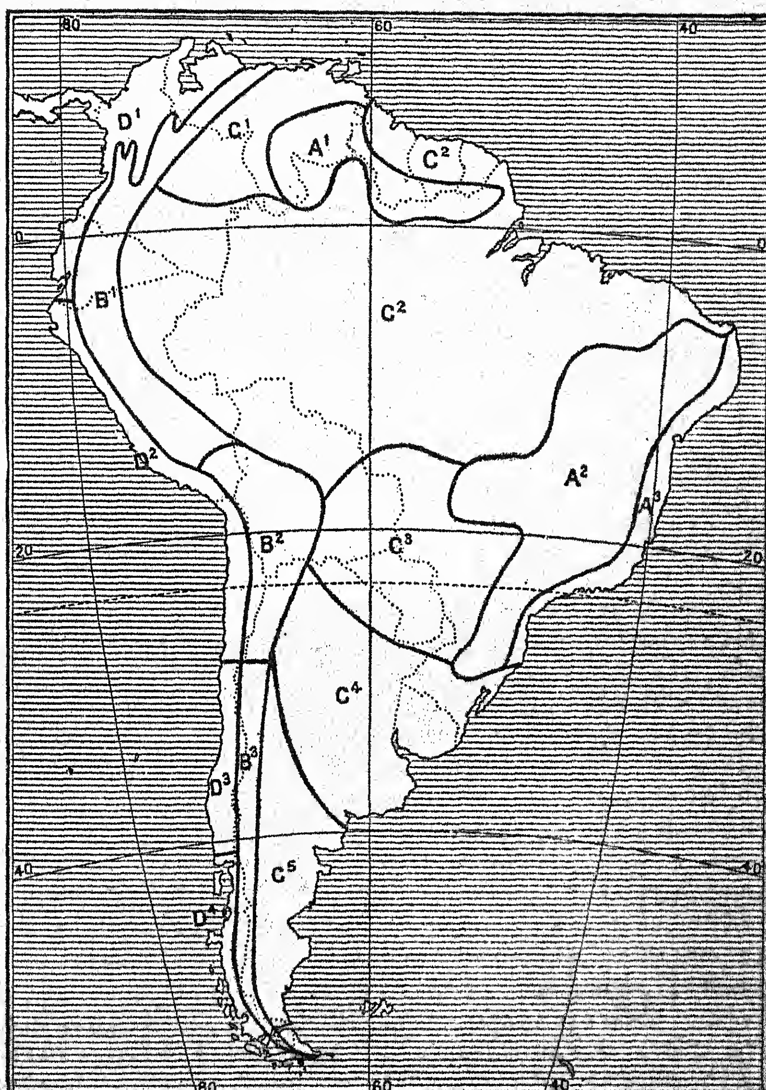

FIG. 131.—South America. Natural Regions.

most important feature. Since the Sun's altitude alters but little through the year, the ranges of temperature are small, so that, for example, the higher valleys and basins enjoy a perpetual "spring" climate. Mineral wealth is abundant.

B². *The Bolivian Plateau.*—The plateau itself is arid and has a scanty vegetation, affording a poor pasture-land. Of its mountain borders a large proportion of the eastern ridges is well watered and shows the succession of vegetations of the equatorial Andes, while the western ridges descend to the arid coast and are almost treeless. Mineral wealth is again abundant.

B³. *The Southern Andes.*—Bare, jagged peaks, steep-sided valleys, extensive snow-fields and glaciers, lakes and mountain pastures, are among the features of this region which is of little commercial importance, save where copper mines occur.

The Central Plains.

C¹. *The Orinoco Plains.*—These alluvial plains, the Llanos, are almost entirely covered with grasses, and are suitable for cattle-ranching. The Orinoco delta forms a swampy jungle.

C². *The Equatorial Lowlands.*—These lowlands include the greater part of the Amazon basin, and the old peneplain which forms the coastal belt of Guiana. They are for the most part densely forested, but sometimes the forest is replaced by savannahs, especially on the slightly higher ground between the rivers. The products of the equatorial forest, e.g. rubber, gums, dye woods and cabinet woods, are here found in abundance, and the whole region is suitable for tropical plantations.

C³. *The Upper Paraguay-Parana Region.*—These plains are tropical and have a fairly heavy rainfall, although neither heat nor moisture is so great as in the Amazon basin. The vegetation is a rich savannah varied by wood-land and (in the west) thorn-bush, and both tropical agriculture and cattle rearing can be carried on.

C⁴. *The Lower Paraguay-Parana Region.*—These plains have a temperate climate, and the rains which are sufficiently abundant and frequent in the east decrease towards the west, so that the latter often suffers from drought. The whole area is suitable for cattle rearing, and the better-watered parts for the agriculture of the temperate zone, especially cereals.

C[5]. *The Southern Scrublands.*—This area is a low plateau rather than a plain, it includes Patagonia; the scanty rainfall and vegetation make it naturally suitable only for pastoral pursuits, but at the base of the Andes there are abundant streams for irrigation purposes, and towards the south-west there are some well-grassed districts.

The Western Margins.

D[1]. *The Moist Equatorial Belt.*—This area is similar in climate, vegetation and products to the other equatorial lowlands.

D[2]. *The Arid Belt.*—This almost desert area can be made use of only in Peru where perennial streams come down from the Andes, but owing to the drought great beds of soluble nitrates are present in the southern (Chilean) portion.

D[3]. *The "Mediterranean" Belt.*—This is the region of winter rains and evergreens, a land of grains and fruit. The most fertile part is the valley between the coast ranges and the Andes proper.

D[4]. *The Temperate Belt.*—This well-wooded region must be likened to north-western rather than to western Europe, for the cold ocean-current keeps the summers very cool, even though the winter cold is not great.

POLITICAL AND ECONOMIC CONDITIONS

With the exception of Brazil and the Guianas all South America was once Spanish, and although the Spanish rule has disappeared and a number of republics have been formed, a large proportion of the people are either of Spanish or of mixed Spanish and Indian origin, while the Spanish language is everywhere spoken. In Brazil, the dominion of Portugal has been replaced by a republican form of government, while Portuguese remains the official language. The Guianas are still European possessions, belonging respectively to Britain, Holland and France.

There is now a considerable immigration into the regions lying south of the Tropic of Capricorn from several countries of Europe. The scantiness of the population is shown by the fact that whereas the area of the continent is nearly twice that of Europe, its population is only 50 per cent. more than that of Britain.

BRAZIL

Natural Regions.—*Central Plains :* Part of the Equatorial Lowlands (C^2) ; part of the Upper Paraguay-Parana Region (C^3) ; part of the Lower Paraguay-Parana Region (C^4). *Eastern Highlands :* Part of the Guiana Highlands (A^1) ; the Brazil Highlands (A^2) ; the Eastern Tropical Margins (A^3).

Economic Conditions.—Brazil occupies about half of the continent, and has a population of over forty millions.

From the equatorial lowlands rubber and cacao are obtained; the Amazon affording an unbroken waterway through this region from the Atalantic Ocean to the Andean highlands. Rubber export has greatly declined, and the river-ports Manaos far up the Amazon and Belem (Para) near the mouth of the Para have little trade. In the fertile region of the east (compare the region in Figs. 95 and 113) are the ports Pernambuco, Bahia (São Salvador), Rio de Janeiro and Santos. Sugar is grown widely over this region; cacao and cotton are obtained from the more northerly coastal strip, and coffee is produced in the hills near the tropic. The chief centres of the coffee trade are São Paulo, behind its port Santos, and Rio de Janeiro. The latter city is the capital and the largest city, having nearly 2 million inhabitants. In the extreme south of Brazil, cattle-rearing has become an important industry. Brazil is extremely rich in minerals and some iron, gold and manganese are obtained. Mining and manufacturing are little developed, partly owing to the poor means of communication, for with the exception of the main stream of the Amazon the rivers are impeded by rapids and falls, and railways have only been extensively built behind Rio de Janeiro and São Paulo. Coffee and cotton are the chief exports.

THE ARGENTINE REPUBLIC

Natural Regions.—*Central Plains :* The southern extremity of the Upper Paraguay-Parana Region (C^3) ; part of the Lower Paraguay-Parana Region (C^4) ; the Southern Scrublands (C^5). *Western Cordillera :* Part of the Bolivian Plateau (B^2) ; the eastern part of the Southern Andes (B^3).

Economic Conditions.—Argentina in size and population (13,000,000) is second to Brazil, and is rapidly developing in

consequence of the relatively cool climate which favours European immigration, and the flatness of the land which has permitted the easy construction of a network of railways in the east of the country. These railways have made possible the extensive cultivation of maize and wheat which are exported. The sugar-cane is grown under irrigation round Tucuman, and much alfalfa is grown for livestock. The rearing of cattle and sheep is important, the products of this industry (wool, mutton, beef, hides, tallow and butter) supplying more than half the exports of the country. The railways converge upon Buenos Aires, which is the capital and the chief port of the country; it is the largest city in South America, having about two million inhabitants. Rosario is a large river-port and an important railway centre, and Bahia Blanca has a hinderland of growing importance. The Argentine railways are connected with those of Chile by the "Trans-Andine" line, which pierces the crest at a height of 10,000 feet, close to the Uspallata Pass, first passing Mendoza, an important fruit-growing centre.

URUGUAY

Uruguay is bounded on the west by the Uruguay river and shares with Argentina the characteristics of the Lower Paraguay-Parana plains (C^4); it therefore produces maize and wheat, but its most important industries are cattle and sheep rearing. The products (wool and meat) are largely exported from Montevideo, the capital.

PARAGUAY

This state lies entirely within the Upper Paraguay-Parana region of the Central Plains (C^3). Its chief agricultural products are tobacco, maté or Paraguay tea, maize and oranges, and cattle-rearing is carried on. The capital is Asuncion at the junction of the Pilcomayo and the Paraguay rivers connected by rail with Buenos Aires.

BOLIVIA

Natural Regions.—*Central Plains:* Part of the Equatorial Lowlands (C^2); part of the Upper Paraguay-Parana Region (C^3). *Western Cordillera:* Part of the Bolivian Plateau (B^2).

Economic Conditions.—The Plateau region has great mineral

deposits, including tin, silver, lead, copper and gold. The silver mines of Potosi have been famous for centuries. The lowland forests yield some rubber. The difficulties of transport, due to the mountainous relief and the inland situation of Bolivia, have hindered the development both of mining and agriculture; railways reach La Paz, the largest town, from the small Pacific port of Antofagasta in Chile and from Arica. Tin is the chief export. The population is over 3,000,000, mainly of Indian origin.

CHILE

Natural Regions.—*Western Margins:* Part of the Arid Belt (D^2); the "Mediterranean" Belt (D^3); the Temperate Belt (D^4). *Western Cordillera:* Part of the Bolivian Plateau (B^2); the Western part of the Southern Andes (B^3).

Economic Conditions.—The nitrates and iodine of the arid belt are important products and are exported from Iquique. Also of great importance is copper from the mountains, and other minerals are gold, silver and iron; behind Coronel some coal is mined.

In the "Mediterranean" region wheat and other cereals, fruits (including the vine) and tobacco are grown; dairy-farming and sheep-rearing are also carried on here, while in the temperate region of the south mixed farming, forestry and fishing are the occupations. Manufactures are the chief imports, minerals the exports.

Santiago is the capital and the largest city; Valparaiso, its port, is next in size. The population of Chile is nearly 5,000,000.

PERU

Natural Regions.—*Western Margins:* Part of the Arid Belt (D^2). *Western Cordillera:* Part of the Equatorial Andes (B^1); part of the Bolivian Plateau (B^2). *Central Plains:* Part of the Equatorial Lowlands (C^2).

Economic Conditions.—The agriculture of the arid coastal strip is carried on entirely by irrigation from the mountain streams; the chief crops are sugar, cotton, maize and rice. On the mountains and plateau, cattle, the llama and alpaca are reared, and there are valuable copper, gold and silver and lead mines in this part of the country. Oil is another important mineral.

The forests of the eastern slopes of the mountains furnish cinchona and other products, and some balata rubber is obtained from the equatorial lowlands. Coffee is increasingly grown on the mountain slopes.

These products support a population of nearly 7,000,000. The capital and largest city is Lima, which lies a few miles from the coast; its port, Callao, carries on most of the foreign trade of the country. From the ports Callao and Mollendo railways climb the Andes to the plateau region.

ECUADOR

Natural Regions.—*Western Margins:* Part of the Equatorial Belt (D^1). *Western Cordillera:* Part of the Equatorial Andes (B^1). *Central Plains:* Part of the Equatorial Lowlands (C^2)

Economic Conditions.—The moist equatorial coastland yields cacao (the chief export) and sugar; on the slopes of the mountains coffee and cinchona are obtained, and such products of temperate regions as wheat and potatoes are grown in the higher valleys. The coast region yields petroleum; in the mountains gold is mined and other minerals exist. The capital, Quito, is in the Andean region at a height of 9,000 feet, and the port of Guayaquil is the chief commercial city. The Galapagos Islands, a volcanic group, belong to Ecuador.

COLOMBIA

Natural Regions.—*Western Margins:* Part of the Equatorial Belt (D^1). *Western Cordillera:* Part of the Equatorial Andes (B^1). *Central Plains:* Part of the Orinoco Plains (C^1); part of the Equatorial Lowlands (C^2).

Economic Conditions.—From the coast bananas, rice, cotton and tobacco are obtained, and coffee at higher elevations, while wheat cultivation and cattle and sheep rearing are carried on in the valleys, particularly those of the Cauca and Magdalena rivers. The mines yield oil, gold, silver and platinum. The Cauca and Magdalena rivers are the chief means of communication. The capital, Bogota, lies among the mountains and is connected with the Magdalena by railway; the next largest town is Medellin,

a mining centre on the opposite side of the valley. The plains east of the Andes are but little utilized.

VENEZUELA

Natural Regions.—*Western Margins:* The north-eastern part of the Equatorial Belt (D^1). *Western Cordillera:* The north-eastern part of the Northern Andes (B^1). *Central Plains:* The north-eastern part of the Orinoco Plains (C^1). *Eastern Highlands:* The north-western part of the Guiana Highlands (A^1).

Economic Conditions.—Sugar, cacao, and rice are the chief products of the coastal lands, coffee being grown on the Andean slopes. Cattle-rearing is the chief occupation on the Llanos, and hides are exported. There are large mineral deposits, but only gold and oil are mined to any extent. Venezuela is one of the chief oil-exporting countries of the world. The capital, Caracas, lies behind the chief port, La Guaira, with which it is connected by railway.

THE GUIANAS

Natural Regions.—*Central Plains:* The northern coastal extension of the Equatorial Lowlands (C^2). *Eastern Highlands:* Part of the Guiana Highlands (A^1).

Economic Conditions.—The most important product is sugar, and in the coastal regions cacao, rice and tobacco are also obtained. There are valuable mineral deposits in the highland region, and gold, diamonds and bauxite are worked. Georgetown, in the district of Demerara, is the capital of British Guiana and the largest town of the whole region. Paramaribo is the chief town of Dutch Guiana, and Cayenne of the French territory.

The **Falkland Islands** are a British possession of little value. The natural vegetation is of grass and scrub, and sheep-rearing is the staple industry. Whaling is also of importance round the dependency of South Georgia.

AUTHORITIES AND BOOKS FOR FURTHER READING.

C. F. Jones: *South America* (Allen and Unwin).
Géographie Universelle, Tome 15, par P Denis (Paris: Colin).
E. W. Shanahan: *South America* (Methuen).

CHAPTER XXIX

AFRICA
PHYSICAL CONDITIONS

RELIEF AND STRUCTURE

Main Divisions.—The continent of Africa lies almost symmetrically about the equator, extending from lat. 37° N. to lat. 35° S., but at the Gulf of Guinea it narrows suddenly, so that the southern mass has but half the width of the northern. No continent has a coast-line so little broken as that of Africa, and this simplicity of outline is matched by a simplicity of structure and of relief. Vast deposits of sedimentary rocks undisturbed by any folding alternate with massive outcrops of old crystalline rocks such as granite and gneiss, the whole forming a tableland bordered by broken terraces and escarpments. In the extreme north-west the Atlas Mountains form a separate structural division (see Fig. 55); they are part of the folded mountain system of southern and central Europe. In the extreme south-west also there is a region which forms no part of the tableland; here a folded mountain system far older than the Atlas was long ago worn down to a peneplain, and the present land is a block of this which was again uplifted and is now carved out into a new series of ridges and valleys. The large continental island of Madagascar, separated from the mainland by the deep Moçambique Channel, remains as a relic of a former land connexion with India.

The Tableland.—A characteristic of the tableland is its rim or border, which rises somewhat above the general level of the interior and falls abruptly to the sea. This is well seen in the Nieuwveld Mountains and the Drakensberg Mountains, which form this rim in South Africa; from the coastal regions they have all the appearance of mountain ranges, but from the interior they are approached by gentle slopes. The Drakens-

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berg Mountains culminate in the Mont aux Sources (11,000 ft.), and the boldness of their ridges is due largely to a resistant sill of igneous rock, which has here pushed its way between the sedimentary layers. The Matoppo Hills and the lofty Bihé or Angola highlands, which also form part of the rim, are masses of hard crystalline rock.

The comparatively low tableland of northern and central Africa, averaging 1,500–2,000 feet above sea-level, may be contrasted with the high tableland of the east and south which averages 3,000–4,000 feet. In East Africa a series of fractures on a gigantic scale has affected the relief. Great crustal blocks have been let down between parallel faults, forming the rift valley shown in Fig. 55. In the deeper hollows of this valley lie long narrow lakes, such as Nyasa, Tanganyika and Rudolf. Irregular fractures and subsidence have also probably helped to form the shallower Victoria Nyanza, which is as large as Scotland. These crustal movements were accompanied or followed by volcanic outbursts, and the tableland is studded with cones, among which may be mentioned Kenya (17,000 ft.) and Kilimanjaro (19,000 ft.), both now extinct. Ruwenzori (16,800 ft.) is a block of old rocks left upstanding by the edge of the great rift. The Abyssinian highlands, bordered to the east by the steep wall of the rift, are largely built up of lavas poured out over a foundation of old crystalline rocks.

The Atlas Region.—The parallel mountain chains run roughly from south-west to north-east, and are loftiest in the west. Farther east two outer chains enclose a high plateau which has been levelled partly by the erosion of the inner ridges, partly by the filling of the valleys; this is the Plateau of the Shotts, so called because of the shallow brackish lakes or shotts which lie upon it. Immediately to the south of the eastern Atlas ranges is a depression, part of which lies below sea-level; this area, too, is dotted with shotts.

The South-Western Ridges and Valleys.—The axes of folding of the old mountains run parallel to the edges of the tableland, and this direction is now followed by the hard, outstanding quartzite ridges such as the Langebergen and Zwartebergen. Between the Zwartebergen and the Nieuwveld Mountains lies

the low plateau known as the Great Karroo, while south of the Zwartebergen is the still lower Little Karroo. This is one of several broad open valleys cut by the rivers along the softer outcrops, and drained southward through narrow gorge-like openings or kloofs across the resistant ridges.

CLIMATE

Winds and Rainfalls.—The outstanding feature of African climate is the northward and southward swing of the belt of convectional rains, fed by the north-east and south-east trade winds. In the Gulf of Guinea the south-east trade is drawn across the equator, and for the greater part of the year blows towards the land as a south-west wind, causing the heavy surf which makes this coast so dangerous. The equatorial belt with no dry season is bordered in succession by belts where a comparative drought lasts for one, two, three, and finally four seasons. In no other continent are the arid belts which lie between the region of convectional rains and the region of westerly wind rains so clearly marked. The great bulk of the land lying about the northern tropic, and the existence of a land mass to the east of it, make the Saharan region the largest desert area in the world. The corresponding dry region lying about the southern tropic, the Kalahari, is much more restricted in area, for here the lofty eastern border of the tableland is subject to easterly winds from the Indian Ocean in every season but winter, and so has fairly abundant relief rains. The effect of relief is also marked on the eastern shores of Madagascar, where the highlands rise sharply from the sea, and in lofty Abyssinia, where the summer rains are very abundant. The Atlas region and the extreme south-west of the continent lie in the path of the stormy westerlies for part of the year, but from both the belt swings away pole-wards in summer, so that in this season they have the drought characteristic of the Mediterranean type of climate.

Temperature.—Only in the loftier parts of the extra-tropical areas, such as the Atlas region and the high south-eastern tableland, can the temperature even in winter be described as cool; the equatorial regions are hot at all seasons, while the tropical regions are very hot at the season of the summer solstice

and warm at the season of the winter solstice. On those parts of the tableland which lie above 4,000 feet the moderating effect of altitude is appreciable, and throughout the year the heat is never excessive. The cold Benguela ocean current flows along the south-west coast, but as the general trend of the wind here is parallel to the shore, the cooling effect is confined to the coastal strip influenced by local sea-breezes, and inland the temperature rises rapidly in spite of the increasing elevation. In the arid regions the rapid daily temperature changes consequent upon the dryness and clearness of the atmosphere are very marked.

DRAINAGE

The general configuration of Africa, that of a level tableland rising to a somewhat higher rim and then falling steeply to the sea-board, causes marked peculiarities in the rivers. The divides between their head-waters are often ill-defined; in their middle courses the streams flow sluggishly and often spread out over wide flood-plains, while in their lower courses they enter wild gorges and descend by falls and rapids to the sea.

The Nile.—The Nile rises on the high eastern tableland where it drains Victoria Nyanza and Albert Nyanza, the latter a rift-valley lake; its descent to the lower northern tableland is effected by a series of rapids, after which its velocity is checked, and its waters, together with those of the Bahr-el-Ghazal and other affluents, spread out over a great plain lying between 5° N. and 10° N. This plain is overgrown with reeds and papyrus which are often torn up by the wind and then gradually accumulate in the closely packed floating masses known as the sudd, which block up the river channels and seriously impede navigation. This plain is drained to the north by the White Nile, which is then joined by the Blue Nile, whose head-waters have cut deep steep-sided cañons into the basalt plateau of Abyssinia. Apart from Lake Tana (or Tsana) near its source, the Blue Nile has neither lake nor flood-plain to regulate its flow or rob it of its silt, and when the heavy summer rains occur it rushes down to the Nile, bearing with it fertilizing mud. The Atbara, too, which is a chain of pools in the dry season, carries a great volume of water after the rains, and it is to these two rivers that the Nile owes

the regular yearly rise, which begins in late summer and culminates in autumn. The lower Nile flows between limestone or sandstone bluffs in a valley from 2 to 15 miles wide, its course being broken by six cataracts, which are a series of boulder-strewn rapids caused by hard rocky sills which lie across the river-bed; finally the Nile splits into several distributaries, and discharges its waters into the Mediterranean Sea by a lagoon-fringed delta.

The Niger.—The Niger rises on the inner side of the escarpment of the tableland that faces the Gulf of Guinea, and flows inland almost to the desert margin, there spreading out over a flood-plain; then sweeping round it flows south-eastwards, and before it is swollen by the Benue breaks across the rim of the tableland in a series of rapids. Near sea-level its velocity is checked, and with the silt which it can no longer carry it has built up an enormous delta crossed by a network of channels.

The Congo.—The Congo rises on the high tableland between Lakes Tanganyika and Nyasa, and with its tributaries flows into an almost circular basin-shaped hollow with a level floor largely covered with alluvium. The enormous volume of water collected in this basin finds its way out westwards across the high borderland by a deep narrow channel broken by falls. The surplus waters of Lake Tanganyika drain intermittently to the Congo.

The Orange.—The Vaal and Orange rising on the inner side of the high and well-watered south-eastern rim of the tableland, and uniting to flow with diminishing volume across an otherwise riverless arid region, may in these respects be compared with the Nile. The lower Orange leaves the tableland by a magnificent waterfall, and follows a winding gorge to the sea.

The Zambesi.—This river flows over the southern tableland, and is separated only by a swampy divide from the Congo basin; in its upper middle course both the main stream and its tributaries are bordered by flood-plains, but its lower middle course is broken by the Victoria Falls, where its waters tumble 450 feet into a narrow zig-zag gorge. Still lower down it crosses a level coastal plain of considerable width and receives the waters of the Shiré, the outlet of Lake Nyasa, before emptying itself through a delta into the Moçambique Channel.

The Inland Drainage Areas.—The Shari flows from a comparatively well-watered district towards the arid Sahara, and its waters spread out and are evaporated in the shallow island-studded Lake Chad. Similarly the Kubango carries the water condensed on the Angola highlands to the Salt Pans on the borders of the Kalahari desert.

Apart from the Nile, there are no perennial streams in the Sahara, but the dry channels of the rivers which drained it during a rainier epoch are still often marked by a chain of pools, or are converted into rushing torrents by the rare but heavy rainstorms which occur. On the higher regions such as Tibesti the rains are less infrequent, and the intermittent streams of wadies are very numerous. In many places the supplies of underground water are considerable and may gush out as springs or can be tapped by shallow wells.

VEGETATION AND ANIMALS

Vegetation.—The Equatorial Forests.—Evergreen forest clothes the coastal belt along the Gulf of Guinea and a great part of the Congo basin, although in the latter region it is interspersed with savannah, and large areas have been gradually cleared by the natives. Flowering trees, palms, orchids and creepers are numerous, and among the more useful products are mahogany, ebony and rubber trees, a wild coffee shrub, and near the coast the oil-palm.

The Savannahs.—Bordering the forest region are vast expanses of grassland dotted over with such trees as palms, acacias and baobabs; at great elevations even these trees may be absent, while in moister valleys or on mountain-sides the tree growth may be sufficiently abundant to form a forest; again, where the ground is sandy and infertile the grasses may be entirely replaced by a thorny scrub, or where it is unusually fertile, as in some parts of the volcanic eastern tableland, a carpet of fine grasses may replace the coarse tufts of the typical savannah.

On the high extra-tropical tableland of the south-east the stretches of almost treeless grassland (the Veldt) must be classed with the temperate steppes rather than with the tropical savannahs. The eastern slopes of the Drakensberg Mountains are

well wooded, but except near the coast palms are not included among the trees.

The Scrublands and Deserts.—Thorny or succulent shrubs and bushes such as acacias, cactuses and aloes cover large areas, including the borders of the Sahara, the Tibesti Mountains and Ahaggar Plateau within the Sahara, the Somali peninsula, the greater part of the Kalahari region and that part of the tableland lying south of the lower Orange river. In the northern scrublands, and especially in Somaliland, gum-acacia and such aromatic plants as balsam, frankincense and myrrh are abundant, while the Karroo region is covered by a low bush about three feet high, which forms excellent pasture for grazing animals. Large areas in the Sahara, a long strip bordering the south-west coast, and some smaller areas in the Kalahari, may be described as true deserts, being almost entirely devoid of plant life.

Regions of Evergreen Trees and Shrubs.—In the regions of summer drought in the north-west and south-west of the continent there appears the characteristic vegetation of the Mediterranean type, consisting of rather small evergreen trees, bushes and shrubs, aromatic herbs and bulbous plants. The better-watered slopes of the Atlas Mountains bear patches of forest of cork and evergreen oak, together with myrtles, laurels and olive groves. The drier Plateau of the Shotts is almost treeless, and alfa grass, sweet-smelling herbs, aloes and cactuses form a vegetation similar to that of the semi-arid Iberian plateau. In the Cape region of the south-west, heaths, irises, lilies and flowering shrubs are among the most abundant forms, and eucalyptus trees have been successfully introduced from the similar region in south-west Australia.

Animals.—In the dense forests man-like apes, the chimpanzee and gorilla, are found, together with numerous monkeys, birds and insects. Among the larger animals are the elephant, which once extended over the whole continent south of the Sahara wherever it could find fodder, and the hippopotamus, which frequents the great rivers and lakes. The grazing animals of the grasslands, such as giraffes, zebras, gnus and antelopes, with the beasts of prey which follow them, the lion, leopard, hyena and jackal, have been gradually driven back before settlers and

colonists, and their numbers have been greatly diminished by big-game hunters. In the arid regions there are ostriches, gazelles, jackals, hyenas, and many smaller animals, most of which are coloured to harmonize with the bare rocks and sand.

Among insects the tsetse fly is important, because it is the carrier of blood parasites which cause the fatal sleeping sickness in man and an equally fatal disease in domestic animals; in a similar manner the parasite which causes malaria is carried by a mosquito. These insects breed in quiet well-shaded waters, such as swamps and rivers with forested margins, so that by draining the land and cutting down the vegetation along the river-banks much can be done towards exterminating them. At present they are still abundant in most of the valleys and low-lying areas clothed with equatorial forest, but they are only infectious when they have bitten an infected man or animal.

Transport is effected across the northern deserts by the one-humped camel or dromedary; so far no successful attempt has been made to use the elephant as a beast of burden in the fly-haunted forest regions.

NATURAL REGIONS

A. **The Equatorial Forest Region.**—In this region, which includes the Guinea margins and the greater part of the Congo basin, the rainfall averages 60 inches, and falls at all seasons, or during at least three seasons. The Guinea region is difficult of access owing to the surf, but in the Congo region there are thousands of miles of navigable waterways.

B. **The Sudanese Savannahs.**—This area includes a rich southern belt suitable for both agriculture and stock-raising, and a more arid belt of scrubland bordering the desert and suitable only for pasture-land. But even in this drier belt enormous crops can be raised on the areas flooded by the Middle Niger, the Shari and the upper reaches of the Middle Nile.

C. **The Abyssinian Highlands.**—This is a high volcanic table-land, dissected by erosion, and the land forms include deep narrow cañons, and broader valleys separating flat-topped, grass-covered mesas (see p. 69). The climate is tropical in the lower valleys

and temperate at greater altitudes; the products vary accordingly.

D. The Southern and Eastern Savannahs.—This part of the

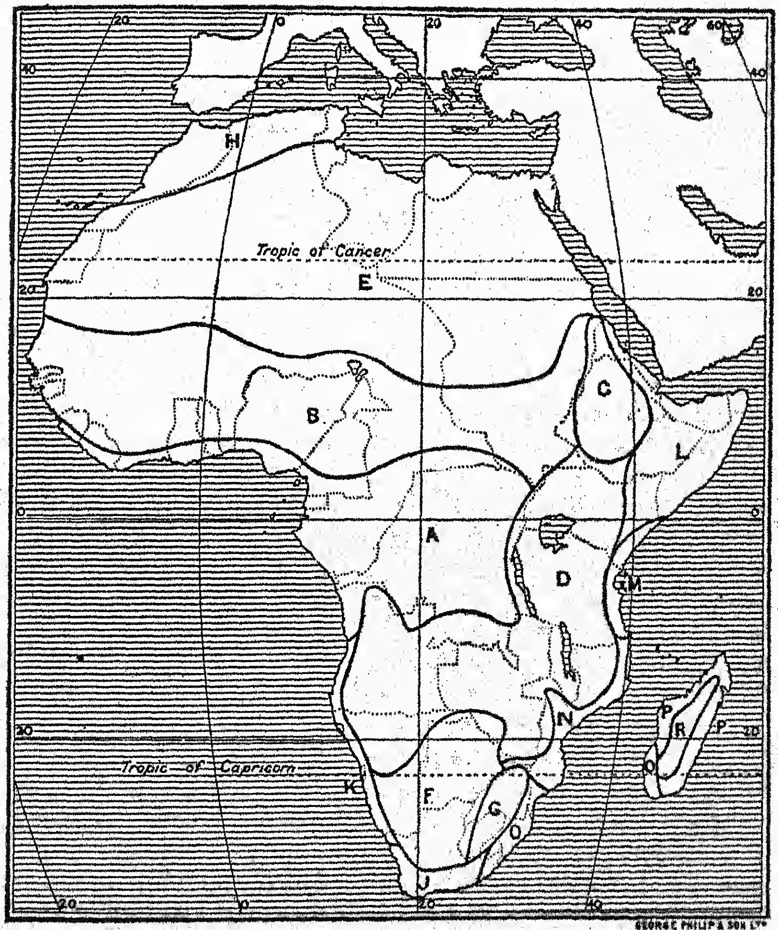

FIG. 132.—Africa. Natural Regions.

high tableland includes the region of the Great Rift and the neighbouring volcanic areas, together with the Zambesi basin. Although the vegetation is burnt up during the season of drought,

the annual rainfall is everywhere over 30 inches, and is sufficient for agriculture as well as for stock-raising. The areas above 4,000 feet have an excellent climate.

E. **The Saharan Desert and Oases.**—This region is built mainly of horizontal layers of limestone and sandstone, pierced here and there by masses of crystalline rock; the old dry valleys separate table-topped mesas with cliff-like edges, sculptured and under-cut by the sand blast (Fig. 32). Among other characteristic features of an almost rainless region are the monotonous stretches of sand-dunes, the bare gravelled plains, and the great masses of rock shattered into fragments by changes of temperature. The green strip of vegetation bordering the Nile and the oases grouped along the wadies and around the springs form the sources of wealth in this region.

F. **The Kalahari and Lower Orange Scrublands.**—This region is largely a monotonous sandy plain, trenched by water-courses which are usually dry, yet along which there is some tree growth. Here and there solitary relic mountains or kopjes rise above the general level, and in the hollows lie salt-encrusted mudflats, occasionally transformed into shallow lakes. To the west the altitude increases considerably, and here the deep valleys bear witness to a rainier epoch, during which mountains were carved out which now lie half buried under their own waste. Most of the water supply is brought to this region by streams from neighbouring rainier areas, and where this is available pastoral industries can be carried on. Elsewhere springs and water-holes lie far apart.

G. **The Temperate Grasslands.**—This region, which forms the better part of the South African Veldt, has a rainfall of over 20 inches, rising towards the Drakensberg Mountains and in Basutoland to 30 inches; in the wetter regions agriculture is possible, in the drier, pastoral industries are more important.

H. **The Atlas or Mediterranean Region.**—The climate and vegetation of the Mediterranean type of region have already been emphasized. The fertile and well-watered hills and valleys near the coast from the Tell, which is an agricultural region, while the drier Plateau of the Shotts is mainly pastoral. The wild mountainous regions of Morocco are little known.

J. **The Cape Region.**—Owing to the fact that the mountains lie parallel to the coast, this southern region of the Mediterranean type is somewhat arid, and all the rivers and streams are made use of for irrigation purposes.

K. **The South-western Margin.**—This almost desert strip, where rain may be absent for years, is chiefly noteworthy because it prevents easy access to the economically more important savannah and scrublands behind it.

L. **The Somali Scrublands.**—This peninsula has a rainfall of less than 20 inches, and has no permanent streams, so that it is suitable only for pastoral industries and has a nomadic population.

M. **The Equatorial Eastern Margins.**—This coastal belt has an abundant rainfall, and is generally similar in climate, vegetation and products to the Congo region.

N. **The Tropical Eastern Margins.**—In this region are included the Lower Zambesi and Lower Limpopo valleys, which are forested and unhealthy but suitable for crops requiring great heat and moisture. Rain falls only in summer, and the average is about 30 inches.

O. **The Warm Temperate Eastern Margins.**—This region rises in successive terraces to the Drakensberg Mountains, and is abundantly watered by rain and swift-flowing rivers. There is a rich vegetation of grass and trees, and while on the coastal strip tropical products can be grown, the higher terraces are suitable for temperate cereals and for dairying.

P, Q, R. **Madagascar.**—This island is bordered by a low-lying belt (P) which is hot, well watered and well forested except in the south-west (Q), where it lies beyond the convectional rain-belt, and is sheltered by the highlands from the easterly trade winds, and so is somewhat arid. The lofty interior forms a high savannah (R), and here the temperature is moderated by the altitude.

The Smaller African Islands.—The Cape Verde Islands and the Canary Islands are of volcanic origin and as they lie in the trade wind belt are rather dry except where peaks such as Tenerife cause some condensation. Fernando Po, Principe and São Thomé are also volcanic, and lie in a straight line with Kamerun

Peak, an extinct volcano on the mainland. Their abundant rainfall, uniformly high temperature and fertile volcanic soil combine to make their plantations unusually rich. St. Helena and Ascension are barren volcanic islands which rise from the submarine ridge which divides the Atlantic Ocean throughout its length into eastern and western basins.

The Seychelles, Réunion and Mauritius lie in the moist equatorial belt, and as they have fertile volcanic soils they yield valuable plantation products.

POLITICAL AND ECONOMIC CONDITIONS

Although Africa is part of the Old World, the greater portion of the continent has but recently been opened to civilized peoples and its economic importance is not great.

The early civilization of the lower Nile was followed later by that of the Atlas region, but these as well as European influences were limited by the Saharan desert. Arab and Indian traders have for many centuries settled on the east coast, and in the fifteenth and sixteenth centuries the Portuguese explored the whole of the coastal regions. Yet much of the interior remained unknown until the latter half of the nineteenth century, owing partly to the climate of the coastal lowlands and partly to the structure of the country, the gorges and rapids of the rivers affording no natural entries through the highland rim.

South of the Sahara the only region which favoured European occupation was the Cape region (J), where the Dutch settled in the seventeenth century. From this region, which became British at the beginning of the nineteenth century, European peoples have spread northward over the temperate grasslands and the warm temperature margins (G and O), but elsewhere the few Europeans are either traders or the representatives of the European Powers which between them have annexed almost the whole of the continent.

BRITISH AFRICA

Union of South Africa.—The Boers of Dutch origin migrated north-eastwards from the Cape in consequence of its acquisition by the British. Beyond the Orange River they formed the Orange Free State, and beyond the Vaal River the Transvaal. Here they engaged in pastoral work and administered their states independently of the British Government.

The discovery of gold in the Transvaal led to an immigration of many British subjects, and this to a conflict of interests which culminated in the Boer War of 1899–1902 and the annexation of the Transvaal and the Orange Free State to the British Empire. In 1910 the four colonies, the Cape Colony, Natal, the Transvaal and the Orange River Colony, were joined into the Union of South Africa with a common Parliament and administration, the constituent provinces having assigned to them the names given in the following paragraphs. The Parliament meets at Cape Town, while Pretoria is the administrative centre.

The Cape of Good Hope is the largest and most populous province of the Union of South Africa, having an area more than twice that of the British Isles, but a population of about 4,000,000 of whom about 800,000 are of European origin. It includes the Cape region (J) and the southern portions of the Kalahari and Lower Orange scrublands (F), and of the warm temperate eastern margins (O).

The people are largely engaged in agriculture and pastoral industries. Maize ("mealies"), oats and wheat are the chief cereals, and wine and fruits are produced, though not in large quantities, in the Cape region; sheep farming is important, wool being one of the chief products of the province, while goat and cattle-rearing and ostrich-farming are of less importance. The chief mineral wealth is in diamonds, from the older fields of Kimberley, and newer ones in Namaqualand. Some coal is mined, chiefly at Indwe on the south-eastern margin of the plateau behind the port of East London.

Railways from the interior reach the coast at several ports, the largest of which are Cape Town on Table Bay, with by far the greatest amount of trade, Port Elizabeth on Algoa Bay, and

East London. The line from Cape Town to Kimberley is carried through the part of the province called British Bechuanaland to Mafeking on the northern boundary, whence it proceeds through the arid or semi-arid Bechuanaland Protectorate into Rhodesia. From De Aar junction a branch goes north-westward, reaching the coast of South-west Africa at Lüderitz and Walvis Bay.

Natal.—The province of Natal extends from the coast, where it forms part of the warm temperate region (O), to the Drakensberg Mountains and the temperate grasslands (G). It has little more than 2,000,000 inhabitants, of whom very few are Europeans. Maize is the chief product, while sugar-cane and tea are cultivated on the coast plain ; sheep and cattle-rearing are also carried on. The mineral wealth is considerable, coal and a little gold being the chief minerals worked. The coal deposits are mainly on the margin of the plateau, with Newcastle as the centre. Pietermaritzburg is the seat of local government, and Durban is at once the largest town and the chief port of the province.

Orange Free State.—This province, which lies between the Orange and Vaal Rivers, consists mainly of the temperate grasslands (G), which as yet support a very small population of less than half a million people, engaged mainly in stock-farming and wheat and maize growing. The chief mineral product is diamonds, obtained from the region adjoining the Kimberley district. The provincial capital is Bloemfontein, in a central position and at the meeting-place of the chief railways.

Transvaal.—The Transvaal extends from the Vaal to the Limpopo, comprising the northern part of the temperate grasslands. It is larger than the Orange Free State, but the chief difference between the two provinces lies in the fact that the Transvaal has great mineral wealth, in addition to the pastoral and agricultural possibilities of the Veldt. By far the most important product is gold, mined in several parts, and especially from a ridge, the Witwatersrand (or Rand), which stretches for more than fifty miles across the south of the country. The centre of this district is Johannesburg, which has grown rapidly in consequence of the mining development, and is far larger than

the capital, Pretoria. Expensive machinery has to be employed in crushing the gold-bearing rock, and therefore great companies have been formed which employ native labour—white miners being comparatively few. Coal is abundant, and is now mined principally near Johannesburg. Diamonds are obtained from the south-west of the province. Maize, oranges, tobacco and wool are the chief farm products.

Railways connect the Transvaal with the sea by four routes: (1) eastward through Portuguese territory to Lourenço Marques; (2) southward through Natal to Durban; (3) south-westward through the Orange Free State to Port Elizabeth; (4) an almost parallel route through Kimberley to Cape Town, by which most of the gold is conveyed.

Between the Transvaal and Natal lies the small territory of Swaziland, a native state under the direct control of the British Government, as is also Basutoland, a rather larger and more rugged plateau between the Orange Free State and Natal.

Rhodesia.—This area is divided into two parts: Southern Rhodesia, which includes Matabeleland and lies south of the Zambesi River, and Northern Rhodesia, which extends to the Belgian Congo and reaches Lake Tanganyika. Southern Rhodesia is a British self-governing colony, although it has only about 60,000 Europeans among a native population of twenty times that number. Northern Rhodesia is a British colony which has scarcely 10,000 white people to about one and a half million natives. Between Rhodesia and Lake Nyasa lies the Nyasaland Protectorate, which has a southward extension on either side of the Shiré River. The whole area forms the south-eastern part of the savannah-lands (D).

Although Rhodesia lies entirely within the tropics, the elevation of much of the country renders the climate suitable for European occupation. At present, primitive agriculture and pastoral work are the chief occupations of the population, which is almost entirely native, but the cooler portions will grow wheat and maize. Oranges are being cultivated, and large crops of tobacco are being raised by European settlers. The mineral resources are also considerable; gold is widely distributed over Southern Rhodesia, coal of exceptionally good quality is

to be obtained, and copper, asbestos, zinc, chrome ore, cobalt and other minerals are also worked. The railway running north-eastward from the Cape, which it is hoped will become the "Cape-to-Cairo" line, crosses both Southern and North-western Rhodesia. In Southern Rhodesia the main line runs through the chief centres, Bulawayo and Salisbury, and connects the latter town with the port of Beira, in Portuguese territory, through which most of the overseas trade is carried on. From Bulawayo the railway runs into North-western Rhodesia, crossing the Zambesi at the Victoria Falls, which will provide water-power in great amount. Thence it extends to the navigable reaches of the Congo. The port for the tobacco and plantation products of Nyasaland is Beira.

Throughout British South Africa there are undeveloped agricultural and mineral resources, and this great area may be expected to maintain a European population several times as large as that at present occupying it.

British East Africa.—This includes (1) The Zanzibar Protectorate, consisting of the islands of Zanzibar and Pemba, from which cloves are the chief produce, (2) Kenya Colony and Protectorate, including the coastal strip (the equatorial marginal region M), and a part of the eastern savannahs (D), and (3) the Uganda Protectorate, the plateau between the Albert Nyanza and the Victoria Nyanza. As in the savannah-lands farther south, so in British East Africa considerable agricultural development is probable, and the coastal strip is very fertile; the mineral resources are not yet well known. A railway connects Victoria Nyanza with Mombasa, the chief port of British East Africa. Coffee from Kenya, cotton from Uganda and fibres from the coast are the chief exports.

A protectorate has been established over the Somali Coast, on either side of Berbera on the Gulf of Aden.

British West Africa.—Of the British possessions in West Africa, Nigeria is the largest and most important. It is divided into two Protectorates, Southern Nigeria, which lies in the equatorial forest region (A), and Northern Nigeria, which belongs to the Sudanese savannah-lands (B). These protectorates comprise one of the most densely populated parts of Africa

(see Fig. 113) and have very valuable agricultural resources, which are now being developed. From Southern Nigeria palm-oil and kernels, cocoa, ground-nuts and cotton are exported; the last two are also obtained from the lower portions of Northern Nigeria, and in the higher portions cattle, sheep and goat-rearing are carried on. North of the Niger delta is a coal field, and valuable tin deposits are mined on the plateau. The chief port is Lagos, from which a railway leads inland to Northern Nigeria, but the lower Niger and its great tributary, the Benue, are the chief means of communication. The Hausa negroes engage in industries such as the making of cotton and leather goods at their capital, Kano, and trade from such centres as Sokoto and Yakuba with all parts of North Africa. The seat of the government of Southern Nigeria is Lagos; the of Northern Nigeria is Zungeru. The total population is over 20 millions.

Smaller, but in many respects similar, are Gambia, producing ground nuts, Sierra Leone, producing palm nuts and oils and diamonds, and the Gold Coast Colony, a leading source of the world's supply of cacao as well as an exporter of gold.

EGYPT AND THE ANGLO-EGYPTIAN SUDAN

Egypt was declared an Independent State in February, 1922, and in 1936 an Anglo-Egyptian treaty of alliance recognised special British interest in the Suez Canal Zone—as a route to India and Australia. South of the 22nd Parallel lies the territory known as the Anglo-Egyptian Sudan, administered under the joint control of the British and Egyptian Governments.

The southern and eastern parts of the Anglo-Egyptian Sudan belong to the Sudanese savannah region (B); the rest, together with Egypt, is a part of the Sahara region (E) redeemed from the desert by the Nile. Upper Egypt is the narrow alluvium-covered valley, and Lower Egypt the delta of the river; to both the annual floods bring water upon which the agriculture entirely depends. In Upper Egypt cereals are grown on the land after the annual submergence; in Lower Egypt and the Fayum depression to the south-west of the delta, canals supply water from the river throughout the year, and here the fertile soil and the constant heat and moisture allow crops to be obtained

in quick succession—wheat, maize, cotton, rice and the sugar-cane being the most important products. On these the population of Egypt, about 17,000,000, largely subsists, and the necessity of efficient irrigation has led to extensive works, including great dams at Assuan and Sennar to regulate the supply of water. With irrigation the Anglo-Egyptian Sudan grows cotton.

The value of the Nile as a means of communication is greatly lessened by the series of cataracts from that at Assuan to that below Khartoum where the Blue Nile joins the main river. One railway leads from the delta up to Assuan ; another crosses the desert from the second cataract at Wadi Halfa to Abu Hamed, avoiding the great western bend of the river, and then proceeds to Khartoum and El Obeid. From Atbara and Sennar lines cross the Nubian desert to Suakin and Port Sudan on the Red Sea. At the head of the delta stands Cairo, the capital of Egypt ; at the north-western corner is Alexandria, the chief port ; at the north-eastern corner is Port Said, at the entrance to the Suez Canal. This canal is in Egyptian territory, and the fact that it is largely used by British ships is one of the chief reasons for British influence in Egypt. Cotton is the chief export.

FRENCH POSSESSIONS

Algeria, of which Algiers is the chief town, and Tunis, whose capital bears the same name, form the eastern part of the Atlas region (H). They have passed into the possession of the French, who have extended their rule southward over most of the western Sahara and much of the Sudanese savannah-lands, reaching the Guinea coast at several points, and thus including a portion of the equatorial forest area ; in the Congo region French territory extends south of the equator.

From the Tell are obtained wine, olives, wheat and barley ; the Plateau of the Shotts yields alfa or esparto grass (from which paper is made), and pastures many sheep. South of the Atlas the French have planted millions of date palms, even within the margin of the desert where wells have been sunk to obtain the necessary water. Caravans from this area cross the desert to Timbuctu.

Madagascar has been annexed as a French Colony. Forest

and savannah-lands alike are productive, minerals are abundant, but communications are as yet very poor. The capital is Antananarivo, in the highland region; and Tamatave is the chief port.

FORMER GERMAN POSSESSIONS

Togoland and the Kamerun Protectorate lie partly in the Sudanese savannah-land and partly in the coastal part of the equatorial forest; they have been divided and are administered by Britain and France in connexion with the adjoining territories, under mandates from the League of Nations, while the ex-German Tanganyika Territory is similarly administered by Britain. German South-west Africa has been joined to the Union of South Africa; the northern part is of the savannah type (D), but the south is semi-arid (F), and the coast is desert (K).

PORTUGUESE POSSESSIONS

In West Africa, the Portuguese territory of Angola includes a part of the equatorial forest region (A), a poorly watered coastal strip (K) and a richer elevated savannah-land (D) resembling the adjoining territory of Rhodesia. The chief town is Loanda, one of the few good ports on the western coast of Africa. A small portion of the Guinea coast is Portuguese. Portuguese East Africa, Moçambique, comprises most of the tropical eastern margin (N) with the ports Lourenço Marques, on Delagoa Bay, Moçambique and Beira, besides the navigable courses of the Limpopo and Zambesi. Sugar is the chief product.

ITALIAN POSSESSIONS

Libya (Tripoli) is semi-arid with some fertile areas near the coast, and the desert with some oases inland.

Italian East Africa includes: Eritrea, of moderate fertility, by the Red Sea; Italian Somaliland, semi-arid or desert, by the Indian Ocean; Ethiopia (Abyssinia) in the interior. Ethiopia comprises the greater part of the Abyssinian Highlands (C), together with portions of the savannah-lands (D) and the Somali scrublands (L) in the east; it has a population of about 8 millions, and has considerable possibilities of agricultural and mineral development. It was annexed by Italy in 1936, and the seat of government is Addis Ababa.

OTHER STATES

Morocco occupies the eastern part of the Atlas region. It is in theory a monarchy, but actually divided into a small Tangier Zone, a larger Spanish Zone, and a much larger French Zone. The chief town and port is Casablanca, connected by rail with the towns of the interior. Agriculture is the main occupation, but there are varied mineral resources and phosphates are exported. South of Morocco is the Spanish territory of Rio de Oro.

In the centre of Africa lies the huge area of the **Belgian Congo**, whence palm-oil and nuts, cotton, coffee and ivory are obtained. The mineral wealth is very great, and the chief exports are gold, copper, tin and diamonds. Communications are aided by the long navigable reaches of the Congo and its tributaries, and railways avoid the rapids near the coast and in the interior, and also connect the mining Katanga region of the upper Congo with the Atlantic through Portuguese Angola.

Near the western end of the forested Guinea coast is the republic, **Liberia,** originally a colony for freed American slaves.

The Smaller African Islands.—The Azores are a volcanic group rising from a submarine ridge; they belong to Portugal and produce fruits. Madeira is also Portuguese and produces wine. It lies on the mail route to South Africa, and with an equable sunny climate is a resort for invalids. The Canary Islands are Spanish, and produce bananas and early vegetables; on Gran Canaria is a fueling station. Fernando Po is also Spanish. The Cape Verde Islands, São Thomé and Principe are Portuguese; the two latter have valuable plantations of cacao.

Ascension and St. Helena on the west, and Mauritius and the Seychelles on the east, are British and serve as fueling stations for the British navy. Réunion is French; both this island and Mauritius export cane-sugar.

AUTHORITIES AND BOOKS FOR FURTHER READING.

W. Fitzgerald: *Africa* (Methuen).
Géographie Universelle, Tomes 11-12 (Paris: Colin).
F. Jaeger: *Afrika* (Leipzig: Bibliographisches Institut).

CHAPTER XXX

AUSTRALASIA

AUSTRALIA—PHYSICAL CONDITIONS

Shape, Position and Extent.—Australia is at once the smallest and the most isolated of the continents. The shallow waters of Torres and Bass Straits, less than 100 fathoms deep, separate it from the islands of New Guinea and Tasmania respectively. These are both of the continental type, and owe their separation to the erosion and subsidence of intervening land-masses.

The continent is compact in shape, and has its greatest extension from west to east. It lies between parallels 10° S. and 40° S., and is roughly bisected by the Tropic of Capricorn. Thus it does not extend into the equatorial belt, and is separated by a wide ocean from the Antarctic regions. To the east lies the island-studded Pacific, to the west the Indian Ocean. To the north the East Indian Archipelago forms a series of broken links between Australia and South-east Asia.

Rêlief and Structure.—*Main Divisions.* Australia falls into three divisions: the western tableland, the eastern highlands, the central plains. These correspond to a western mass of very ancient rocks, long undisturbed; an eastern uplifted block, mainly of old rocks; and a depressed area, in which extensive deposits of later sedimentary rocks have been laid down, and left undisturbed. There are no recent folded mountain ranges.

The Western Tableland. This old tableland has a general altitude of less than 2,000 feet, but it is not absolutely level; the MacDonnell Range and Musgrave Mountains, for example, rise above 3,000 feet. The steep edges or escarpments of the tableland when viewed from the sea-board appear like mountain ranges; this is especially the case in the south-west, where they have received the names of Darling and Stirling Ranges.

The Eastern Highlands. These highlands are old uplifted peneplains which are being re-dissected by rain and stream erosion; they, too, present steep escarpments seawards, while inland they slope more gradually towards the plains. When once their abrupt borders are surmounted, they are seen to have a plateau-like character, and cannot correctly be described as mountain ranges; the name Great Dividing Range sometimes applied to them is therefore misleading. Owing to the great diversity of the rocks of which the highlands are formed, there is a great variety of landscape, the harder rocks tending to form abrupt ridges while the softer present more rounded outlines. The greatest altitudes are found in the south and south-east, where various names, such as Australian Alps, Blue Mountains, Liverpool and New England Ranges have been given to different parts of the highlands. Mount Kosciusko, a flat-topped summit, rises above 7,000 feet, and is the highest point in Australia.

Tasmania is an isolated portion of the eastern highlands, and presents the appearance of a plateau, deeply dissected by rivers. It has an altitude of over 5,000 feet in Ben Lomond.

The Central Plains. These plains are for the most part under 600 feet, and in the Lake Eyre depression sink below sea-level. To the south-east of the plains lie the South Australian Highlands, including Mount Lofty and Flinders Ranges, blocks of old rocks which overlook the depression containing the Gulf of St. Vincent, Spencer Gulf, and Lake Torrens. This depression is a rift valley, formed by the subsidence of a crustal block along parallel faults running from north to south.

Minerals.—The most valuable minerals are usually associated with the more ancient rocks. Thus in Australia the mining districts are found mainly on the western tablelands and on the eastern highlands (including Tasmania). They only occur in the central plains where the later sedimentary rocks have been removed by erosion and the older foundation is exposed. Gold, silver, tin and copper are all mined in considerable quantities. Rocks containing productive coal-seams are found in the eastern highlands and near the south-west margin of the tableland. Those beds which crop out close to the shore to the north and south of Sydney in New South Wales are the most conveniently

situated for exploitation, and hence are at present the most valuable.

Coasts.—The coasts have been mainly formed by fractures and subsidences, but in some places a slight uplift has added a narrow plain of later sediments to the continental area. That the mainland was once more extensive is shown by the surrounding islands, such as Kangaroo, Melville, and numerous smaller ones; in their formation and structure they are exactly similar to the adjacent parts of the continent from which they have been separated. In the north-east the shoal waters, bordered by the Great Barrier Reef, mark the former extent of the land. This reef, which is the largest formation of living coral in the world, almost closes Torres Strait, and extends nearly to the Southern Tropic, beyond which limit the waters have not the uniformly high temperature necessary to the coral polyp.

The uniformity of relief of the interior is matched by the unbroken nature of the coasts. The only important indentations are Spencer Gulf and the Gulf of Carpentaria. The former is, as has already been explained, part of a rift valley. The latter is merely a part of the depression between the western tablelands and eastern highlands which has sunk below sea-level; the waters which cover it are shallow. Lofty limestone cliffs border the Great Australian Bight in the south.

Climate.—Although Australia is an island, there are two facts which combine to limit oceanic influences to its margins. In the first place its outline is almost unbroken, in the second place the higher lands are found near the coast and shut off the interior from the sea. Hence the greater part of the continent is characterized by extreme dryness and intense summer heat. If the mean annual isotherm of 20° C. be taken as a criterion, only the south-west and south of the continent, with the eastern highlands south of latitude 25° S., lie outside what has been defined as the torrid zone (p. 132). In the hottest month (January) much of the interior lies above 26° C. (80° F.), even allowing for the effect of altitude. In July, only a comparatively small area in the south-east, together with the extra-tropical eastern highlands, can be described as cool. On the Australian

Alps, the area above 3,000 feet has cold winters, the higher summits having a July temperature below the freezing point. The range of temperature is nowhere excessive, owing to the mild winters; on the margins it is less than 10° C. (18° F.), while in the heart of the continent it is somewhat above 30° C. (54° F.). The presence of a great ocean instead of a land-mass on the poleward side of Australia accounts for the difference between its winter temperatures and those of North America or Asia in the same latitudes.

The variation in the winds and rainfall is well illustrated by the seasonal rainfall map (see Fig. 83). In Northern Australia summer rains prevail; the high temperature in the interior is accompanied by low pressure, and the winds flowing towards this low pressure area from the equatorial seas precipitate their moisture over the land. The N.E. trade wind is drawn across the equator, and being deflected to the left becomes the N.W. monsoon of Australia. Towards autumn, as the sun moves northwards, the low pressure area also migrates, so that in this season only the northern fringe of the continent receives monsoon rains. In winter the interior of the continent forms part of the dry planetary high pressure belt, and the winds tend to be outflowing. It is noticeable, however, that these outflowing airs are not strong enough to alter the direction of the south-east trades, which still bring rain to the eastern highlands south of the tropic.

The southern parts of Australia lie in a region of summer drought; the chief rains are in the winter six months, when the procession of cyclones of the stormy westerly belt comes sufficiently far north to affect the continent. This winter precipitation usually takes the form of snow on the south-east highlands. The effect of the swing of the wind belts is also noticeable on the extra-tropical eastern margins. In the summer, when the trade belt has its most southerly position, the on-shore winds are reinforced by the low pressure in the interior which has already been noticed, and the whole of the east coast has rains. In the winter, when this belt has moved northwards, the moving cyclones bring rains to the east coast as far north as about latitude 30° S. Tasmania, with its more southerly position,

lies always in the path of the cyclones of the stormy westerly belt, and so has rain at all seasons.

The mean annual rainfall map (see Fig. 84) shows how the heavy rains are confined to the coastal belts and the highlands. Everywhere the rainfall diminishes rapidly towards the interior. The seaward faces of the eastern highlands have over 40 inches, those of the south-western edges of the tableland over 30 inches. The broadest belt of heavy rains is in the north, where the summer monsoon winds prevail for over six months. The effect of relief may be noticed in Mount Lofty and Flinders Ranges and in the Australian Alps, which lie in the path of the stormy westerlies, and have a heavier precipitation than the neighbouring lowlands. In Tasmania the effect of the prevailing wind direction is to give a heavier rainfall in the west than in the east. It is important to notice how great an area of Australia has less than 10 inches of rain. As is the case in the other continents, this very dry region extends right to the west coast, and separates the inter-tropical area with summer rains from the extra-tropical area with winter rains.

In addition to the disadvantage of low rainfall over extensive areas, Australia suffers at irregular intervals from droughts, when the rains for the year fail almost entirely. Fortunately these droughts do not occur over the whole country simultaneously, since the rainfall in different parts is determined by three separate wind systems, the monsoons, the trades, and the westerlies.

Australia may be divided into four climate regions (see Fig. 86).

1. The northern tropical monsoon region, with high temperatures throughout the year and heavy summer rains.

2. The eastern highlands, with rain at all seasons, with cool winters, and without excessive heat in summer.

3. The southern or "Mediterranean" region, with hot summers, warm or cool winters, and with summer drought.

4. The interior region, with low rainfall, great summer heat, and warm winters. Here, owing to the dry air, the insolation and radiation are both rapid, so that the day and night temperatures show excessive contrasts, although the mean temperatures are not abnormal.

Rivers and Lakes.—The extreme dryness of Australia is the cause of its poverty in rivers. According to the relief, two types may be distinguished, those with short swift courses, flowing down the steep continental margins, and those with long sluggish courses flowing over the level interior. Their régime varies according to the seasonal distribution of the rains and to the evaporation. In the eastern highlands, where there is rain at all seasons, the rivers flow perennially, although the discharge is somewhat lessened in spring and summer owing to evaporation and the needs of the vegetation. In the monsoon region, with markedly seasonal rains, the rivers flow perennially, but with a marked difference in volume between the wet and dry seasons. In the dry interior, and on the dry western margins, the rivers only flow after exceptional rains, and are usually a mere chain of water-holes.

The rivers of the well-watered eastern margins are very actively dissecting the highlands, in which they have cut deep gorges; they have not yet smoothed their profiles, and are often broken by rapids and waterfalls. When they reach the coastal plain or the sea, the sudden change of slope causes an abundant deposit of rock waste, so that fertile alluvial plains, deltas and sand-bars are built up. Among the eastern rivers, the Hunter, entering the sea at Newcastle, may be mentioned. It has cut an exceptionally wide valley back into the highlands, making an important gap; this is owing to the unresistant nature of the carboniferous rocks over which it flows. Farther north, the Fitzroy and Burdekin, with their tributaries, have cut valleys parallel to the coast, before turning sharply towards the sea. The explanation of this is that here the graining of the rocks is parallel to the fractured shore-line, and the extensive longitudinal valleys have been carved out along yielding strata.

The rivers of the interior mostly gather into two great basins, the inland drainage area of Lake Eyre, and the Darling-Murray basin draining to the Southern Ocean. The streams from the Queensland highlands, flowing towards Lake Eyre, rapidly diminish by evaporation and by percolation through the surface, and at last the beds become quite dry, or have only occasional water-holes. Such are the Diamentina and Cooper's Creek.

Lakes Eyre, Torrens and Gairdner are not great expanses of water, but stretches of sun-baked mud dotted over with saline swamps and shallow salt lakes, which only occasionally unite into single sheets.

The head-waters of the Darling-Murray river system are similar to the eastward-flowing streams of the highlands; their abundant waters rush rapidly through steep-sided valleys. But when they reach the uniformly level plains their velocity is checked, they can no longer carry their load of rock waste, so that they have gradually raised their banks and their beds, and in some places flow at a level of several feet above that of the surrounding country. This leads to disastrous floods when exceptional rains occur in the highlands. During the spring and summer the great evaporation causes the rivers rapidly to dwindle in volume, and by the autumn they are at their lowest. The Murray itself is exceptional, for it is fed throughout the spring by the snows of the Australian Alps, and so its volume is less diminished. At its mouth the Darling-Murray falls into a large lagoon, Lake Alexandrina, but the opening of this lagoon into the sea is narrow, shallow and encumbered by shifting sand-banks. The rivers are navigable during winter and spring, but large volumes of water are being drawn off for irrigation purposes, which lessens the value of the system as a water-way.

The lack of rainfall on the plains has been partly compensated for by the discovery of underground water. In south-western Queensland and the adjoining portions of New South Wales and South Australia hundreds of borings have been made from which the water flows without pumping. These wells are valuable both for irrigation and for watering the stock.

Soils.—In the eastern and south-eastern highlands, including Tasmania, the great variety of rocks leads to a great variety of soils, sterile sandstones being found side by side with fertile shales or limestones. The margins of these highlands were in a long past age the scene of volcanic outbursts, and from the weathered basalts is derived an exceptionally rich dark-coloured soil. The alluvium brought down by the swift-flowing rivers has already been mentioned. On the interior plains, in addition to the river deposits, the sedimentary rocks themselves yield a

very fertile soil. Attention has already been drawn (see p. 154) to the fact that the soils in arid regions tend to preserve an exceptionally high proportion of valuable mineral constituents, which in wetter regions are gradually washed out. In some parts of the interior there are great stretches of shifting sand, often piled by the wind into dunes, and areas where by the removal of finer particles nothing but pebbles and stones remains; such regions are sterile. In the moist hot tropical belt the soils are usually deep and fertile.

Vegetation.—In a dry continent like Australia the vegetation naturally assumes forms which are resistant to drought. For instance, on many trees the leaves hang vertically in order to avoid the direct rays of the sun, or they are protected on both sides by a thick skin, which gives them a dull or olive-green tint. The characteristic plant is the eucalyptus, of which there are a great many varieties, ranging from small shrubs to trees of gigantic stature; different kinds of acacia, both shrubs and trees, are also very common. The eucalypti are known often as gum trees, the acacias as wattles.

The forested area is confined to the well-watered margins and highlands. It corresponds roughly to the regions with over 30 inches of rain in extra-tropical and over 40 inches in tropical latitudes. In the dense forests of the monsoon region there are many palms, bamboos, wild bananas and orchids, often laced together with a tangle of wild vines. There are also some valuable timber trees such as sandalwood. On the coasts mangrove swamps are found. In Queensland the term " scrub " is used to denote a forest growth, for example the brigalow scrub is composed of acacias. Towards the south the sub-tropical and temperate forests occur. These are more open than the monsoon forest; gum trees predominate, and there is an abundance of tree-ferns. The highlands are only partially forested, and include some rich grassland areas, such as the Darling and Liverpool Downs. On the Australian Alps and the Tasmanian plateaus the heavier rainfall is accompanied by a denser forest growth. In the Mediterranean type of region the most important forests are those of the jarrah and karri trees, two varieties of eucalyptus yielding good timber which are found in south-

west Australia. Over much of this region a scrub or heath-like vegetation is found, where shrubs and low bushes predominate. These heaths are remarkable in spring for their profusion of bright flowers. The mallee scrub of the Lower Murray basin is composed largely of dwarf eucalyptus of the size of large shrubs. Mingled with the heath and scrub are patches and sometimes wide stretches of good grassland.

On the landward side of the forest belt of the north and east is a region which on the whole may be described as savannah and steppe. A profusion of deep-rooted grasses is found, and the trees, chiefly gums and wattles, grow singly, or in clumps, or along the watercourses. The vegetation varies, however, with the soil, and the grasses sometimes give place to a scrub of thorny dwarf acacias, or of succulent salt-bush.

In the yet drier parts of the interior there are great sandy and stony deserts. Among these, considerable areas are covered with spinifex, a tall, sharp-pointed, spear-like grass which grows in clumps. But where there is underground water, or where some mountain range causes more frequent rains, there are found wiry grasses, low bushes, and fleshy succulent plants. No definite boundary lines can be drawn between grassland scrub and desert. Like all arid regions, the interior of Australia presents a totally different aspect before and after a period of drought. The landscape may be bare and brown, with all the appearance of a lifeless desert, until a heavy rainfall occurs, when at once the ground becomes carpeted with green grasses and gaily coloured flowers.

Animals.—Australia has long been separated by the sea from the other great continents, so that most of its animals belong to species not found elsewhere. There are no large grazing animals with the exception of the peculiar kangaroo, and as a result there are no very large flesh-eating animals, the largest being the dingo or native dog on the mainland, and the Tasmanian wolf in Tasmania. In the forested regions there are many animals adapted to life in trees, such as the flying squirrels, opossums, tree-kangaroos, tree-snakes, tree-frogs, and the native bear, a sloth-like animal feeding on leaves. Parrakeets and parrots abound, and in the northern forests there are fruit-eating

bats. The open grassy plains and scrublands of the interior are the home of grazing animals, such as the kangaroos, wallabies, and two kinds of flightless birds, the emu and cassowary. Here, too, burrowing animals, living on such food as worms, insects, grubs, roots and leaves, are very numerous: among them are the native "rabbit," the wombats and kangaroo rats. The introduction of the European rabbit into Australia was disastrous, for, owing to the absence of its natural enemies, such as the fox, stoat and weasel, it multiplied so rapidly as to do great injury to the vegetation. Rabbit-skins are a considerable export. Few of the Australian animals are particularly valuable for their flesh or fur, and none are capable of domestication; they therefore tend to be driven into the poorer unoccupied regions, and will gradually disappear. The camel has been successfully introduced for transport purposes into the arid interior.

NATURAL REGIONS

The Northern and Eastern Coastal Belts. (B).—These regions are characterized by a small temperature range and an abundant rainfall (over 40 inches), the vegetation is of the forest type, and they are suitable for agriculture. Region B^1 has a temperate climate, vegetation and products; B^2 is a warm temperate belt; and B^3 has the climate, vegetation and products of a well-watered tropical monsoon region.

The Eastern Highlands (H).—These regions have a moderate rainfall (about 30 inches) and, as their vegetation of mixed forest and grassland suggests, they are suitable for both agricultural and pastoral industries, including dairying; they are also rich in minerals. The extra-tropical highlands include those of Tasmania and the Australian Alps, which are more densely forested than the remaining regions.

The Transition Belt (T).—This belt is transitional between the moderately watered highlands and the arid interior. It is divided into an extra-tropical region (T^1), which includes the greater part of the Darling-Murray basin, and an inter-tropical region (T^2), which belongs to the monsoon area. The extensive grass and scrub lands which clothe these regions are suitable for stock-rearing.

The Interior (I).—This is the arid desert and semi-desert region with marked temperature changes. Its economic value lies mainly in the existence of minerals, especially gold, in the ancient rocks of the western tableland.

The Mediterranean Type of Region (M).—This is a region of summer drought, with winter cyclonic or relief rains. The

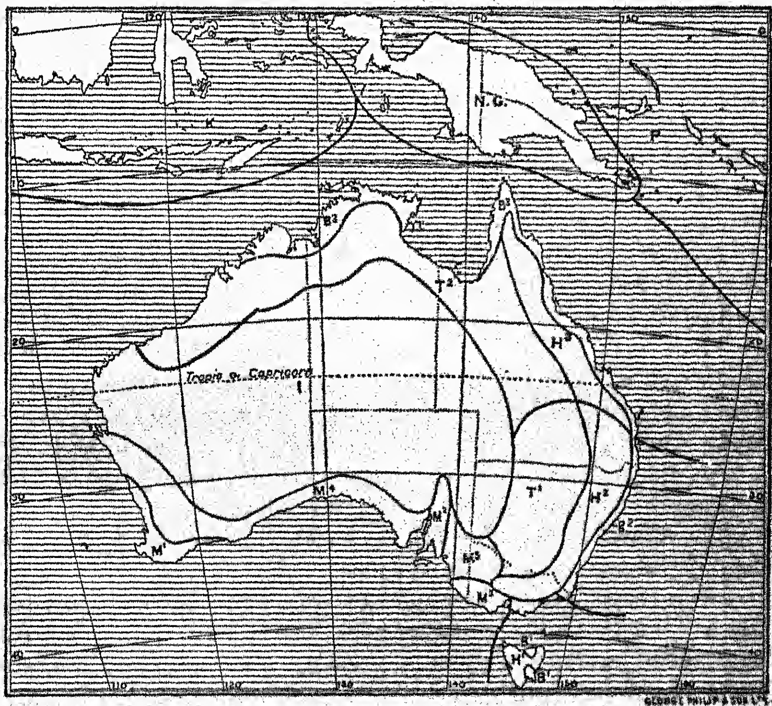

FIG. 133.—Australia. Natural Regions.

areas marked M^1 and M^2 have over 30 inches of rain and are partly forested; they are suitable for agriculture. The region M^3 also has a fair rainfall and is clothed with rich grass and dense scrub; it is suitable for both pastoral and agricultural industries. The drier areas M^4 and M^5 have a vegetation of thinner scrub and heath, and are suitable for stock-rearing only.

POLITICAL AND ECONOMIC CONDITIONS

Historical and Political Survey.—At the beginning of the seventeenth century Torres discovered the strait which has been named after him; soon after this several Dutch navigators sighted the shores of the continent, and in 1642 the Dutch sailor, Tasman discovered Tasmania, though he thought it to be part of the mainland. At the end of the century the Englishman, Dampier found the north-west shores. These discoveries led to no results, partly because the Dutch wished to trade and the land offered no products which they desired, but still more because at most points that were reached the coasts were backed by inhospitable lands, particularly mangrove swamps in the north, the deserts in the north-west, and long stretches of bare cliff in the south.

It was not until the end of the eighteenth century, when Captain Cook sailed along the fertile eastern coast, that the continent became really known. In consequence of his report, a penal settlement was formed at Botany Bay, and shortly afterwards was removed to the spacious harbour of Port Jackson. There Sydney was built, and when the free colony of New South Wales developed, this town became the seat of government.

At the beginning of the nineteenth century, a period of unusual drought incited the settlers to cross the Blue Mountains, and henceforth settlements were slowly made both along and behind the eastern and south-eastern coasts.

Very early a convict station was placed in Tasmania on the site of Hobart, and in 1825 Brisbane, now the capital of Queensland, was founded. About ten years later settlers took up lands by the lake-like inlet of Port Philip, where later Melbourne grew up and became the capital of Victoria. At about the same period the present capital of South Australia, Adelaide, was founded on the shores of St. Vincent Gulf. Of the western half of the continent only the wooded south-west corner attracted colonists, and here the "Swan River Settlement" gave rise to Perth, now the capital of West Australia.

The regions around these six centres gradually became populated, formed separate Colonies, and were granted the right of

independent government. Pastoral work, agriculture and forestry were undertaken by the settlers, but the most notable immigrations were due to the discovery of gold. Thus the discovery of gold at Bathurst in New South Wales in 1851, followed almost immediately by still greater finds in Victoria, led to the sudden influx of hundreds of thousands of people.

The six States, New South Wales, Victoria, Queensland, South Australia, West Australia and Tasmania, united in 1901 to form the Commonwealth of Australia, but they retain their own governments for local affairs.[1] It was enacted that a new capital for the Commonwealth should be created in New South Wales, at a distance of not less than 100 miles from Sydney. Canberra, situated about 150 miles south-west of Sydney in a valley draining into the upper Murrumbidgee, was selected as the site of the Federal Capital and opened in 1927.

The favourable climate of the south-east of the continent is the chief cause of the fact that three-quarters of the total population of seven millions are found in New South Wales, Victoria, and the adjoining portion of South Australia.

Since the continent occupies about 3,000,000 square miles, this population is extremely scanty. The sparseness is least in Victoria, where there is an average of 21 persons to the square mile, but becomes more marked as one considers the States lying farther from this as a centre. Thus the average number of people to the square mile in Tasmania is 9, in New South Wales 9, in Queensland 1, in South Australia 1, and in West Australia 0.5. Even allowing for the barrenness of much of the country it is obvious that there is opportunity for the population to increase to far more than its present amount. Indeed, the lack of labour is a difficulty in the development of the industries, specially hindering the manufactures of the south-east and the agriculture of the north-east.

In much of the hot, moist northern part of the continent the climate, although suited to the growth of such commodities as rice, sugar and cotton, is not favourable to the carrying on of the work by white men. Nevertheless, legislation has prohibited

[1] Northern Australia is administered by the Federal Government.

the importation of Kanaka labourers from the South Seas Islands and has restricted the immigration of Asiatics. This policy of a "White Australia" must postpone the development of the northern portion of the country, but it is hoped that with the increased knowledge of tropical diseases and of the best methods of living in such regions, a white population may adequately occupy them as well as the more temperate parts of Australia.

Pastoral Work and Agriculture.—As the sparseness of the population would suggest, only a very small proportion of Australia (about 1 per cent.) is cultivated. The well-watered coastal lands of the south-east are well used, and so are the winter-rain regions of the extreme south-west and near Adelaide, but the hot north is scarcely touched and the interior is too arid for cultivation except where water is obtained by wells or (as in the Murray basin) brought by rivers and irrigation canals from the mountains.

Of this cultivated land more than half is under wheat, one of the chief sources of wealth; it is grown in the cooler southern half of the continent in the area where the annual rainfall is about 20 inches. Of this Victoria and New South Wales each produce one-third, almost entirely within a belt extending behind the coast with a width of 200 miles (B^2, H^2), while most of the remainder comes from South Australia east of Spencer Gulf (M^2). Only in two States does any other cereal rival wheat, maize being grown to a considerable extent near the tropic in Queensland (B^3) and oats in the cooler Tasmania (B^1). Much hay is also produced.

Behind the eastern coast of Queensland (B^3) about as much land is devoted to the sugar-cane as to either wheat or maize; a comparatively small amount of sugar-cane is also grown in the adjoining part of New South Wales. In this well-watered sub-tropical north-east coast region some cotton is also grown, with tobacco and even a little rice.

In the region with the Mediterranean type of climate the vine is cultivated, though to an extent not at all comparable with that in the great vine-growing districts of Europe. The yield is greatest in Victoria and South Australia (M^2 and M^3), and there is now an export of wine to England.

In the same "Mediterranean" region the typical fruits are grown, particularly currants, figs, almonds, apricots and peaches,

Oranges, too, are grown in these regions, and their cultivation extends, as a somewhat important industry, northward into New South Wales and beyond that region into Queensland, where such tropical products as melons, bananas, and pineapples also appear. Apples are grown largely in Victoria and Tasmania; in this latter State fruit culture is important and gives rise to the making and export of jam.

The cultivated area has increased owing to the growth of population, the extension of railways, the provision of better steamship transport to foreign markets, and the extension of irrigation. Consequently lands at first used only for grazing are now farmed.

The pastoral industries also have benefited by the same developments, and they are now, as in the past, of great importance; sheep and cattle being reared in very large numbers. Occasional droughts have brought about great variations in the numbers of the animals, but nevertheless Australia ranks first among the countries of the world in the supply of wool, and high in the production of meat and dairy produce.

The sheep are reared partly in the cool and well-watered regions of the south in which wheat is grown, and partly in the drier areas of the interior where the rainfall is over 10 inches per annum. Of special importance are the "downs" and plains behind the coastal uplands of New South Wales, and the "Riverina" district farther west; the corresponding areas of Victoria and Queensland also have many sheep.

Cattle are kept partly in the cooler regions with more rain, e.g. the coastal belts of Victoria and New South Wales, and in these areas the dairying industry is centred; they are also reared in the warmer part of the continent, mainly in Queensland, and to a less extent in the Northern Territory and West Australia.

Mining and Manufacture.—Gold ranks with wool and wheat as one of the chief productions of Australia. The great discoveries of gold in the eastern highlands in the middle of last century caused the production of this metal to reach its maximum shortly afterwards, and another great increase followed the finds in the western tableland during the last decade of the century; but in recent years the output has declined, although the resources are not exhausted. Until recently the three States

of the eastern highlands were the most productive; of these Victoria took the leading place, as exceptionally rich deposits were found at several places in this State, notably at Ballarat and Bendigo; in Queensland there were valuable fields round Charters Towers. Now, however, the greater part of the supply comes from West Australia, for the great tableland of ancient rock contains enormous stores of gold, which have led the miners even into the desert interior. In the south, mining has extended past the Southern Cross area to Kalgoorlie (to which water was pumped from near Perth) and thence in various directions even to the Mount Margaret area. In the centre are the Mount Magnet and Murchison fields. In the north-west is the Pilberry district and in the north-east the Kimberley region.

Most other minerals come from the Eastern Highlands, either on the mainland or in Tasmania. Silver and lead, largely obtained together, are mined in Queensland and in Tasmania, copper in the same States, tin in the highlands of all the eastern States, and zinc in New South Wales and Tasmania. Another important mineral region is Broken Hill, in the west of New South Wales; it is similar in structure to the old rocks forming the Eastern Highlands, with much silver, lead and zinc.

As regards coal, nearly all the annual supply of 14 million tons comes from New South Wales, where Newcastle is the appropriately named centre. Although this yield is only a small fraction of that of the British Isles, the total deposits are estimated to be equal to those of the British Isles.

The resources of iron ore are even less developed, but the output has recently increased and there are valuable ores widely distributed over the continent.

Manufactures are developing slowly, though their growth for the supply of home needs was aided by the relative isolation of Australia from the older industrial countries during the war of 1914-18. The chief industries are in New South Wales and Victoria and include the making of iron and steel goods at Lithgow in a coalmining area, the refining of sugar, and the spinning and weaving of wool. In general they are concerned with the working of home-produced materials to satisfy the home-needs for food, clothing, housing and transport by road and rail.

Communications and Commerce.—The rivers of Australia do not afford good means of communication (see above), and the opening up of the country has therefore been largely dependent upon the construction of railroads. These have been directed inland from many points along the coast, gradually extending into the interior, while other lines have linked together the coastal settlements, but at present only in the south-east is there a network of lines. The short railway near Port Darwin in the north is still isolated, but the line from Perth to Adelaide is complete. The telegraph, however, crosses the continent from Spencer Gulf northwards to Port Darwin.

The largest cities of Australia are, without exception, ports. Sydney and Melbourne each have about a million inhabitants, and together account for not far from one-third of the whole population. As natural centres of the most productive regions they draw to themselves a large proportion of the trade, both home and foreign. Next in importance is Adelaide and after that Brisbane, each on the margin of the better populated area of the south-east of the continent. Beside these capitals, which of course owe some of their growth to the fact that they are political centres, only Newcastle is of any considerable size, but Rockhampton, a growing port in Queensland, is favourably placed on the Fitzroy River, and has connexion by rail with a rich stock-raising and mining hinderland.

In Western Australia, Perth, the seat of the government, is smaller than the other capitals, and Hobart in Tasmania is quite a small city.

The exports reflect the nature of the production—wool being the most valuable, followed by wheat and flour, meat, dairy produce, hides and skins, and metals, especially gold and lead; the chief imports consist of motor cars and machinery, petroleum, cotton and silk goods, chemicals, rubber, tea and tobacco.

NEW ZEALAND—PHYSICAL CONDITIONS

Position and Extent.—New Zealand consists of a group of islands lying about 1,000 miles south-east of Australia, and

stretching between latitudes 34° S. and 47° S. The islands, which are fragments of a greater land-mass once linked up with New Guinea and Eastern Australia, are separated by shallow straits: Cook Strait between North and South Islands, and Foveaux Strait between South Island and the much smaller Stewart Island.

Relief, Structure and Drainage.—New Zealand is essentially a mountainous country, and the general trend of the feature lines is from north-east to south-west, as is seen both in the mountain ranges and the coast-lines. Folded mountains stretch through North Island and through about two-thirds of the length of South Island, where they attain their greatest height and importance as the Southern Alps. The southernmost portions of the highlands of South Island have been carved out by erosion from an uplifted peneplain, itself the relic of an older mountain system in which the trend lines were from north-west to south-east; this older direction of folding is repeated in the Auckland Peninsula in North Island. Crustal disturbances have not yet ceased in these islands; a line of active and extinct volcanoes, hot springs and geysers follows the newer north-east to south-west direction, stretching from White Island in the Bay of Plenty to Mount Raupehu (9,000 feet) in North Island, and earthquakes are not uncommon.

The lofty Southern Alps bear a number of large glaciers, and together with the highlands farther south, were covered by an ice-sheet during the Ice Age (Fig. 33). Many of the ice-deepened or moraine-dammed valleys now contain picturesque lakes, and along the south-west coast where the glaciers once reached the sea there is a series of fiords.

The most important lowlands of New Zealand are the Canterbury Plains, which lie to the east of the Southern Alps and are largely built up of alluvium brought down by the mountain torrents. The Alps form a barrier to communication between the eastern plains and the western coastal district, which is rich in coal and gold: the chief route lies through the Otira Gorge and across Arthur Pass.

Climate.—New Zealand lies in the track of the stormy westerly winds, and has in general abundant cyclonic and relief rains;

the Canterbury Plains, which are sheltered under the lee of the Alps, form an exception, and have only a moderate rainfall: because of their situation they are also subject to a hot dry wind of the foehn type (see p. 130). Owing to the prevailing oceanic influences the temperature range is everywhere small; the winters are mild, and the summers not excessively hot.

Vegetation and Animals.—In consequence of the mild winters and the abundance of rainfall through the year, the forests, which are of the broad-leaved type, are largely evergreen. The kauri pine, which grows in North Island, is a valuable timber tree, and beautiful tree-ferns are everywhere common. The forests are most dense on the wet western slopes of the mountains, on the drier eastern plains there are natural meadows, and on the higher mountain ranges Alpine pastures. Much of the land has been cleared of trees and sown with grasses.

The long separation of New Zealand from the neighbouring land-masses accounts for the number of animals of peculiar types, as for example the wingless birds, of which the largest, the moa, has now become extinct.

As regards natural regions, New Zealand belongs to the western temperate marginal type, North Island bearing some resemblance to those areas of Western Europe and Western North America which are marked as transitional between this and the Mediterranean type.

POLITICAL AND ECONOMIC CONDITIONS

Tasman discovered the islands in the middle of the seventeenth century, they were reported upon by Cook at the end of the eighteenth century, a few missionaries and traders settled upon them in the early part of the nineteenth century, but colonization and annexation by Britain did not take place till 1840. Now the islands form a self-governing "Dominion," yet the population is about one and a half million in a region almost comparable in size and resources to the British Isles. The seat of government is Wellington, a small city at the extreme south of North Island, and therefore placed centrally as regards the whole Dominion.

The extremely early stage of economic development is shown by the fact that the chief occupations of the people are connected with the rearing of sheep and cattle. The former are by far the more numerous, amounting to thirty million and giving a quantity of wool equal to one-third of that obtained from the whole of Australia; moreover, great quantities of lamb are frozen for export. The pastures are far richer than those of Australia, for large areas are covered with specially sown grasses. The Canterbury Plains are famous grazing lands, yielding besides wool and meat from sheep, dairy produce from cattle. Dairy cattle, however, are most numerous in North Island.

Only a very small proportion of the land is under crops other than grass—oats and wheat being the most important, and nearly one-fifth of the country is covered with forest, from which much timber is cut. Although at present very large tracts of country are scarcely utilized, only about one-eighth of the land need be regarded as destined to be permanently unproductive.

Mineral production is not great, for although gold-mining greatly aided settlement in earlier days, little gold is now obtained. Small amounts of coal, and a little iron, are produced in both islands. Water-power is abundant in the well-watered western mountains of South Islands but it is being developed only slowly. Industrial advance is correspondingly slow.

There are no large cities in the Dominion, the most considerable being distributed at approximately equal distances along the length of the islands. They are Auckland in the north, Wellington on Cook Strait, Christchurch on the Canterbury Plains, and Dunedin in the south, and of these Auckland has recently outstripped its rivals and now has about 200,000 inhabitants.

The pastoral industries account for the fact that wool, butter and meat are the most valuable exports; next in value comes more pastoral produce, viz., cheese, hides, skins and leather and preserved milk. As in the case of Australia, the chief imports are iron and steel goods and machinery, and textiles. With the exception of Christchurch, which has as its port the neighbouring town of Lyttleton, the four towns mentioned above are also the largest ports of the Dominion.

NEW GUINEA

The large island of New Guinea consists of a highland region in the north and east with lofty mountain ranges running throughout its length, and a lowland area separated from Australia by the shallow Torres Strait. The climate of the lowlands is of the equatorial type, always hot and moist, and the vegetation takes the form of dense equatorial forest, varied in some localities by savannahs. The animals resemble those of Australia and include the cassowary, wallaby and tree-kangaroo. The climate and rich soil are suitable for tropical agriculture, and the natural forest products include coco-nuts and sago-palms, cabinet-woods and rubber. Much of the country is little known, but it is said to be rich in minerals. The south-eastern portion, Papua belongs to Great Britain, the eastern to Holland, while the north-east, which was German, is administered by Australia.

THE PACIFIC ISLANDS

The numerous Pacific Islands are of two types, the high and the low; the former are of volcanic origin, the cones often rising to an altitude of many thousands of feet, while the latter are mere coral reefs or atolls, usually less than 12 feet above sea-level. All the islands have a luxuriant vegetation.

Among the larger volcanic groups are the Fiji Islands, which are British, and have a population of over 200,000. The export of greatest value is sugar, followed by copra, and there are sugar-, soap-, timber- and fibre-works on the islands. The Hawaii or Sandwich Islands, in the Northern Pacific, were annexed to the United States in 1898. They have a population of nearly half a million, few being Hawaiians and many Japanese. The sugar industry is very important, and is carried on by the most up-to-date methods. The output amounts to about a million tons annually, the bulk of which is shipped to the United States. Pineapples are also very largely grown for export. Honolulu, the capital of Hawaii, is an important port of call for vessels crossing the Pacific from San Francisco to Japan, China, New Zealand and Australia. The United States has also naval stations at Guam in the Ladrone Islands, and at one

of the smaller Samoan Islands which it has acquired. The larger Samoan Islands (previously German) are administered by New Zealand under a mandate from the League of Nations; under similar mandates are governed the other ex-German islands, viz. the Bismarck Islands by Australia, and the groups north of the equator by Japan. New Caledonia is a French possession, and the remaining Pacific islands are in the hands either of France or Britain.

On the coral and other small islands of the Pacific, coco-nut groves form the chief vegetation, and copra, the dried kernel of the coco-nut, is the leading export. It is used in the preparation of soap, edible oils and butter substitutes. On some of the islands, however, there are valuable deposits of phosphates, which are being worked.

LIST OF AUTHORITIES AND BOOKS FOR FURTHER READING.

J. W. Gregory: *Australia and New Zealand* (Stanford).
F. H. H. Guillemard and A. H. Keane: *Malayasia and the Pacific Archipelagoes* (Stanford).
J. D. Rogers: *Australasia; Historical and Geographical* (Clarendon Press).
F. D. and A. J. Herbertson: *Descriptive Geography of Australia and Oceania* (Black).
Griffith Taylor: *Australia* (Oxford Press).
Géographie Universelle, Tome 10 (Paris: Colin).

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